THE ENGINEER

JUNE 25, 1954

Report of the Chief Inspector of Factories

THIS week, there has been published the report of the Chief Inspector of Factories, Sir George Barnett, for the year 1952. It says that, at the end of the year, the number of factories registered was 237,293, which was 1416 less than in 1951. Sir George Barnett's introduction to the report includes a review of industrial developments during the year. It comments on the fact that mechanisation of plant, and in particular mechanical handling, continued to receive attention in all kinds of industry. Furthermore, the number and variety of electronic appliances in industry continued to increase rapidly, and both manufacturers and users recognised that much thought was necessary on the problem of the adequate training of personnel to maintain this kind of equipment. Dealing with safety in factories, the report says that in 1952 the numbers of fatal and non-fatal accidents, 792 and 176,718 respectively, were the lowest recorded since the Factories Act, 1937, came into operation. It is thought that the slight recession in trade may have had some bearing on this, though a reliable guide to the progress achieved is given by the reduction in the accident rate, from thirty accidents per 1000 persons employed in 1937 to 22·5 per 1000 in 1952. The report says that whilst welcome reductions have been reported in many categories of accidents, these results could not be improved upon or even maintained without constant endeavour. The only groups to show an increase were the two transport categories, railways and other vehicles, and it is pointed out that the rapid growth in the numbers of mechanically propelled vehicles of all kinds has presented factory occupiers with problems calling for careful attention. The most striking reduction has occurred in accidents caused by power-driven machinery, where the rate per 1000 persons employed dropped from 5·91 in 1937 to 3·71 in 1952. Transmission machinery produced, in 1952, less than half the number of accidents that occurred in 1937. On the other hand, accidents at prime movers almost doubled in the same period. The report says that the steady increase in this category was clearly unsatisfactory, and that the safeguards of plant should receive much closer attention on the part of factory managements.

Ten-Car Trains on the Southern Region

THE Southern Region of British Railways has now brought into effect the first stage of a scheme for the introduction of ten-car trains on its suburban routes from Cannon Street and Charing Cross. This scheme to relieve overcrowding of certain morning and evening business services is being carried out in four stages, the first of which, between Charing Cross and Dartford via Bexleyheath, was introduced on June 14th. To make possible the introduction of these ten-coach trains the platforms at twenty-five stations have been lengthened. To provide space for these platform extensions it was necessary to alter the tracks and connections at fourteen stations, and this work was particularly extensive at Charing Cross, London Bridge, Orpington, Blackheath, Dartford, and at the Metropolitan Junction between Waterloo and London Bridge. At Slade Green five new berthing sidings have been laid in on the up side of the line and the connections of the nine sidings into the carriage inspection shed completely remodelled at the London end. Other alterations at Slade Green include the extension of the carriage inspection shed by 82ft and the lengthening of the inspection pits. At Dartford the extension of four electrified berthing sidings involved the excavation of some 26,000 cubic yards of chalk and the construction of a concrete facing wall. To provide for the longer trains eleven new two-car units have been built. These new cars, combined with the existing eight-coach trains, will give an increased seating capacity of 186 passengers per train.

Fire Research Report

THE report of the Fire Research Board for 1953 has now been published. In it the chairman, Sir George M. Burt, comments on the increased interest shown by other countries in the work undertaken at the Fire Research Station, Boreham Wood, Herts. Study of the behaviour of building materials when subjected to fire, the carrying out of experiments on flammability and experimental studies of methods and media for extinguishing fires has continued during the year. With the co-operation of the Fire Brigade of the City of Birmingham full-scale trials have been made of the effectiveness of water jets and sprays in bringing fires under control. Basic studies have covered such subjects as the spontaneous heating and smouldering of materials, and work has continued on dust explosions. The report states that it is now possible to extinguish fires in petrol storage tanks by introducing foam into the tank through the supply lines existing at the base of the tanks. These lines are unlikely to be damaged in the early stages of the fire, a shortcoming of foam applicators placed at the top of the tank. The foam reaches the surface at low velocity and does not disturb the surface of the petrol or any existing foam layer in the way that can happen with top application, particularly if the foam falls some distance in reaching it. The technique has already been used successfully in oil tanks, the best results being achieved with foams of an expansion much lower than that given by the normal branch pipe. Foams of a higher expansion absorbed too much petrol during their passage through the tank, and although they controlled the main fire, on reaching the surface a "foam fire" developed in the petrol which had been picked up by the foam itself, and this fire gradually destroyed the foam. On the other hand, foam of a very low expansion drained too rapidly to form an enduring protective layer on the surface of the petrol. The study of the fire resistance of prestressed concrete beams, the effect of fire on prestressing wires and on the crushing strength of concrete at high temperatures has formed another important part of the research programme, and is fully dealt with in the report. The analysis of annual fire statistics carried out by the station is providing valuable information about many kinds of fire and their causes. This information is being used in the study of the effect of the introduction of non-traditional methods of house building on the fire situation in this country. Whereas earlier reports indicated that some innovations in building construction had been responsible for a more rapid development of fire, it is now apparent that corrective measures, to which fire research contributed, have been successful in reducing the rate of incidence of serious fires. Carelessness or ignorance is believed to be responsible in some measure for about half of the fires which occur in dwelling-houses each year.

Survey of Steam and Power Usage

LAST year the Ministry of Fuel and Power initiated a survey of steam and power utilisation in industry in an attempt to estimate the potentialities for the extended use of back-pressure or pass-out engines in the generation of power. The results of this survey have now been embodied in a new section of the Ministry's *Statistical Digest* for 1953, published this week. The information gathered in the report includes the amount of fuel used for steam raising, the use of steam for different purposes, the distribution of the steam load, the type, size and age of the boilers in use and engines installed, the production of mechanical and electrical energy, and the amount of electricity purchased. The survey was limited to the larger establishments, questionnaires being sent only to those believed to be using more than 2000 tons of fuel a year. There are approximately 4600 such undertakings with a total fuel consumption of 63,000,000 tons a year. The return was a voluntary one, but 84 per cent of the questionnaires were completed. Although the establishments contributing to the survey account for only 12 per cent of those consuming more than 100 tons of fuel a year, they cover 73 per cent of the total fuel consumed. Thus, for such matters as the amount of steam produced the survey covers the greater part of the national total. Much of the information given has never before been available. This present report does not consider the possibilities of individual plants. Although it discusses the variable economic and thermodynamic factors involved in any estimates to be made, the report only aims to provide statistical information on which they can be based. It is thought, however, that by employing modern generating plant and using the lowest possible pressures for processing, as much as 10 milliard units could be usefully generated, existing plant contributing about one-third of this amount. Altogether about 700 industrial establishments are expected to have a potential worth exploiting.

Tin Research

THE research work carried out last year by the Tin Research Institute, whose report is published this week, was concerned with the further development of alloys, tinplate, hot tinning and organotin compounds. In a reference to the work on electrodeposition mention is made of the use of tin-lead and tin-antimony as overlays on bearings, and of the recent improved control and economy in the coating of tin on to aluminium by chemical displacement. It is stated in the report that the preliminary difficulties in operating the tin-nickel alloy (2 : 1) coating process commercially have now been overcome, and that with the tin-zinc (3 : 1) coating process several plants of a semi-continuous design and of substantial size were installed during the year, largely for work on domestic refrigerators, and in the aeronautical and automobile industries. Work on tin-aluminium bearing alloys has also made considerable progress. Solid bearings containing 30 per cent tin alloyed with a strong aluminium matrix are undergoing trials on an Italian tramcar; another alloy containing 20 per cent tin bonded to a duralumin backing is being used experimentally in some automotive engines, and a third alloy, containing 15 per cent tin can be bonded to steel shells, and trial bearings are being prepared for several automobile manufacturers. It is stated that the fatigue resistance and the operation of these bearings has proved satisfactory in the laboratory, and no manufacturing difficulties are envisaged. There was also developed a new alloy consisting of copper-manganese-tin, which is almost white, and takes a very high finish, and which it is thought should prove useful in the ornamental fields and in the electrical industry. In the organotin chemical compounds the tin atom is joined directly to a carbon atom, and by this special technique an almost infinite number of new substances can be made. It is only recently that the systematic study of this field has been undertaken and that practical uses for these compounds have been found. The use of dibutyltin compounds as stabilisers for polyvinyl chloride plastics is now firmly established and the current consumption of tin in plastics is measured in hundreds of tons a year. Researches on the trialkyltin and triaryltin compounds are still, the report notes, mainly in the laboratory stage.

Some Recent Swiss Hydro-Electric Schemes

No. X—(*Concluded from page 882, June 18th*)

This series concludes with an account of a scheme on the Maggia River in Southern Switzerland, which will permit the comprehensive development of the river's hydro-electric potentialities, totalling nearly 800 million kWh annually, principally from three power stations, with their associated works, including a seasonal reservoir at the head of the system. These new works include underground power stations of a novel layout, and an experiment to assess the possibility of employing an unlined tunnel under a head of about 150m.

IN Southern Switzerland, the Maggia River which flows into Lake Maggiore close to Locarno, is at present being exploited for hydro-electric power production by a series of three power stations, as shown in Fig. 45. The entire scheme has been under construction since 1950.

There is a seasonal reservoir at the head of the system with the three power stations in series below it, with various subsidiary intakes and reservoirs. The first power station, Peccia, is intended for peak load operation, principally in the winter season ; the second, Cavergno, is for peak load generation throughout the year and the third, Verbano, is for base load operation. Thus, the lowest stage of the scheme is the most profitable and yields the most power ; it depended for its success upon the driving of the long free-flow tunnel (23km in length) from Cavergno to Palagnedra. The improvements in tunnelling technique and rates of progress which have been made during the past few years brought this apparently formidable task within the bounds of practical economy, thus making the whole project more attractive. The principal data for the scheme are given in Table XI.

There are no earlier works in the catchment, although it is a favourable one from the hydro-electric standpoint. One or two earlier schemes were prepared, but did not reach the constructional stage ; they closely resembled the upper stages of the present scheme, but did not include any proposal similar to the present lowest stage.

The works shown in Fig. 45 have been built at a cost of the order of 300 million Swiss francs (about £25,000,000), including the cost of transmission. The transmission lines are also shown ; they are at 225kV, linking with an existing 225kV line at Riazzino and Lavorgo (this line is one of the first of a 225kV network proposed in Switzerland—the existing transmission network is principally at 150kV), and including the substation at Avegno.

The scheme may be extended in the future by three stages of future works. The first stage would be a tunnel from S. Carlo to Peccia, built at about the tail race level of Peccia power station, to double the flow to Cavergno power station. The second and third stages would involve three dams forming reservoirs on the headwaters of two glacial streams above S. Carlo, with diversion works leading to two power stations, one at Robiei, the other at S. Carlo. These additional works would yield mainly winter power. With their completion the economic exploitation of the catchment would be substantially completed, for the right bank tributaries are in general too small to allow further extension there, and the Melezza River above Palagnedra reservoir is in Italian territory.

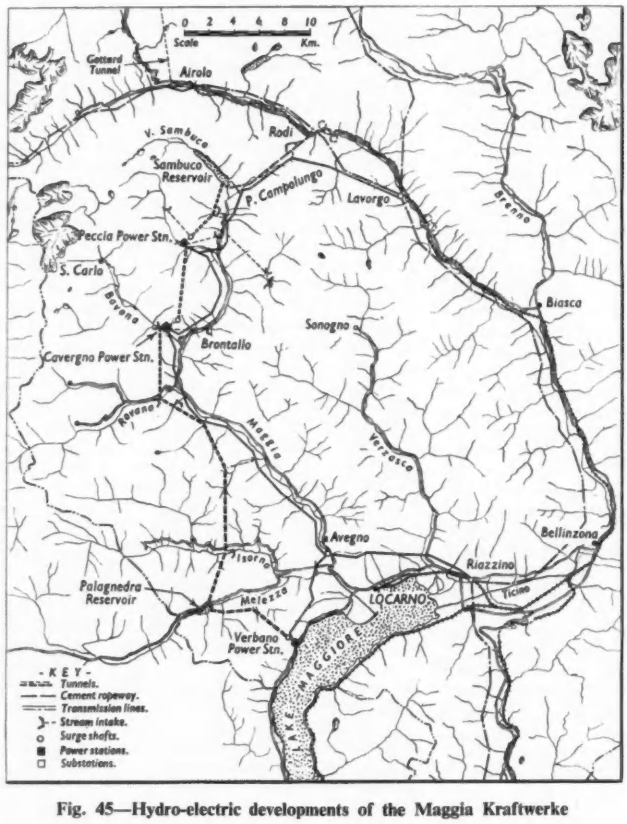


Fig. 45—Hydro-electric developments of the Maggia Kraftwerke

Verbano power station is now substantially complete, and the four turbo-alternator sets are in operation there. The upper works are at a much earlier stage of construction and will not be complete until 1955. Nevertheless, in the description which follows the scheme will be described starting from the head of the system, as this gives a more logical sequence for the purpose of explanation.

Sambuco Dam

A plan and various cross sections of Sambuco dam are shown in Fig. 46. Its construction constitutes one of the major elements of the scheme, for it is a large structure, with a maximum height of 130m and a concrete volume of 770,000 cubic metres. Various dimensions relative to the dam and a key showing the site layout may be observed from Fig. 46. Sambuco dam is an arch-gravity structure, with a massive cross section, in keeping with the Swiss policy in this respect which we have already commented upon.

The plant layout is generally similar to other installations which we have already described. Aggregates are quarried upstream from the dam, where there is a deposit of moraine in the bed of the future reservoir. A road has been built along the right bank of the valley and a stock of aggregate is being accumulated just downstream of the dam close to the aggregate plant. From that plant, belt conveyors carry the graded aggregates (maximum size 150mm) up to the concrete plant, containing three 3 cubic yard mixers. Cement is brought by bicable ropeway from Rodi on the main Gotthard line (see Fig. 45) and stored in silos at the ropeway terminal. There is then a compressed air plant with a pipeline passing through the access tunnel on the left bank (No. 14 in the legend) to the concrete plant. This tunnel is the sole access to the cableway headmasts and to the dam at the high level. There are three principal cableways for placing the concrete and one service cableway. The maximum rate of concreting is about 2000 cubic metres per day.

The concrete is poured in blocks 25m wide extending across the dam in two or three sections. It is cooled with water flowing in pipes embedded in the dam. The construction joints left on each side of the blocks are of zig-zag form, and grouting pipes are incorporated in them so that the construction joints may be grouted later on, when the "green" concrete has cooled to 10 deg. Cent. The form of the construction joints and the cooling pipes laid ready for the next lift of concrete may both be noted in Fig. 48. It is planned to start filling the reservoir in 1955, and to complete the dam in 1956.

A Tunnelling Experiment

The tunnel from Sambuco reservoir to Peccia power station will start from intake

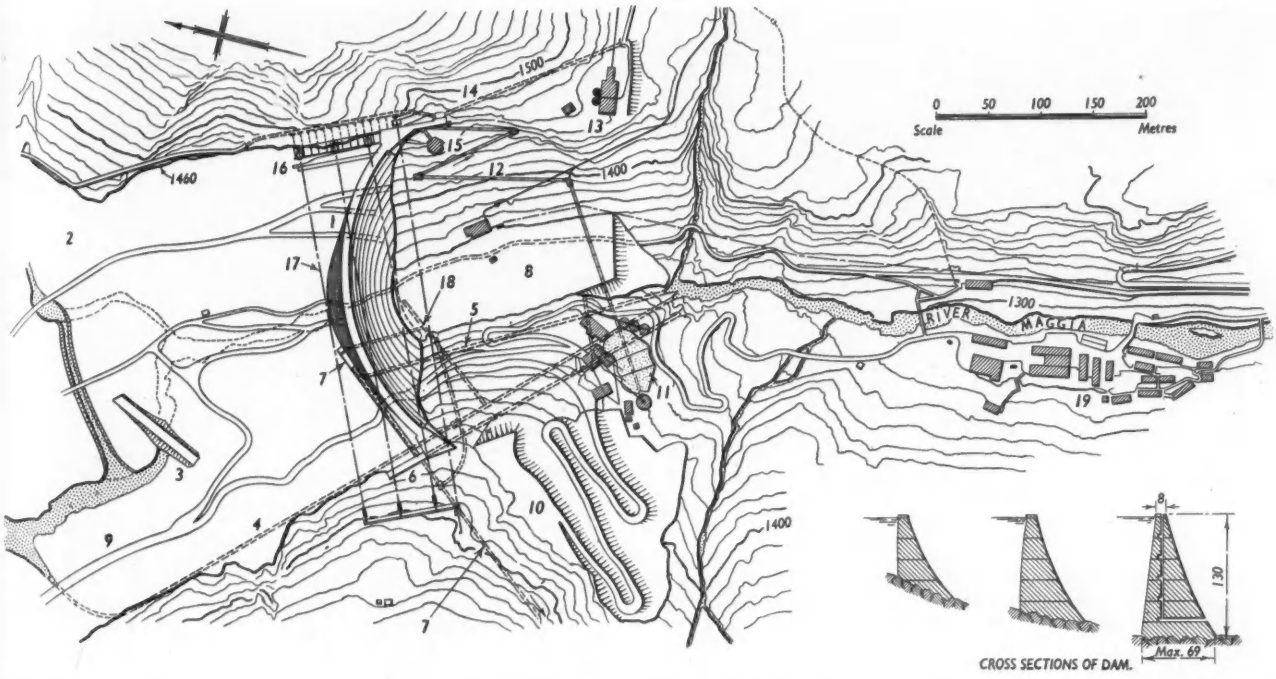
TABLE XI—*Hydro-Electric Development of the Maggia River*

Reservoirs

	Dam	Storage capacity, cubic metres × 10⁶
Sambuco	Arch gravity, 130m high	62
Palagnedra	Gravity, 72m high...	4·8

Power Stations

	Principal machines	Installed capacity, MW	Gross head, metres	Rated flow, cumecs	Power production		
					Summer, kWh × 10⁶	Winter, kWh × 10⁶	Total, kWh × 10⁶
Peccia	Two horizontal Pelton wheel sets, each with two turbines	2×23·5	426	14·5	19	62	82
	Two pumps	2×11	400	4·5	—	—	—
Cavergno	Two horizontal Pelton wheel sets, each with two turbines	2×27·5	509	13·0	103	107	210
Verbano	Four vertical Francis sets	4×25·15	297	44	314	188	502
				Total ...	436	357	794



1—Dam.
2—Reservoir site.
3—Cofferdam.
4—Diversion tunnel (for construction) and bottom level scour culvert for completed reservoir.
5—Middle level scour culvert.
6—Spillway.
7—Intake and tunnel to Peccia power station.
8—Spoil tip for dam excavation and excess of fines from aggregate plant.
9—Road to quarry.
10—Stockyard for aggregates.
11—Washing, crushing and screening plant for aggregate, and screened aggregate stock.
12—Belt conveyors from aggregate plant to concrete station.
13—Terminal of cement ropeway from Rodi, with cement silos.
14—Access tunnel to concrete plant and cableways, with compressed-air-operated cement pipeline from cement silos to concrete station.
15—Central concrete batching and mixing station.
16—Roadway for transporting concrete skip from mixers to cableways.
17—Cableways.
18—Access tunnels.
19—Workers' camp.

Sambuco Dam

Maximum height of dam	130m
Maximum width at base	69m
Length at crest	340m
Width at crest	8m
Radius of upstream face at crest	200m
Total volume of concrete	770,000 cubic metres
Storage capacity of reservoir	62×10^6 cubic metres (51,080 acre-feet)
Maximum reservoir level	1460m above sea level
Minimum reservoir level	1370m
Catchment area supplying reservoir	1112 square kilometres

Cement Ropeway Rodi-Sambuco

Length	7750m
Rise in level, Rodi to Campolungo	1404m
Fall in level, Campolungo to dam site	883m
Capacity	40 tonnes per hour

The ropeway is in two sections, with a common driving station. Cement is carried in 750kg containers. Other material may be carried with a maximum load of 2000kg.

Fig. 46—Plan and cross sections of Sambuco dam

works on the upstream face of the dam, as Fig. 46 shows, and will be 5·3km in length. We have already mentioned the importance of the long free-flow tunnel in the lower part of the scheme, so it may be mentioned that the tunnelling works generally have been carried out by conventional, modern methods of rock tunnelling and without undue difficulty. The maximum rate of tunnel driving recorded by the autumn of 1953 was on one of the adits of the free-flow tunnel, where a length of 21m had been driven in a day. Rates of driving of 200m a month have been averaged for the large free-flow tunnel, and 300m a month for the smaller tunnels, so it will be seen that the progress of the work approximates to that now being achieved on some of the Scottish hydro-electric tunnelling works. The concrete lining for the lower-stage pressure tunnel (the only one completed so far that has required to be lined) was carried out at rates up to 300m a month, with movable steel forms and concrete pumps.

There is, however, one aspect of the tunnelling work which promises to be of considerable technical interest. The completed tunnel from Sambuco to Peccia will be submitted to a hydrostatic head of about 150m when the reservoir is full. At the present time hydraulic pressure tests are being carried out on three test lengths of this tunnel—one near the dam, one near the centre and one near the surge shaft—to determine how the unlined rock of the tunnel will behave when submitted to the 150m pressure head. The main aim of the tests is to ascertain the amount of leakage from the tunnel. If the tests prove satisfactory it is intended to leave the tunnel unlined, except in local zones of poor material. The rock through which the tunnel passes is of good quality, as may be inferred from the remarks above. It consists of granite and gneiss and is generally free from faults and fissures. Should the unlined tunnel be adopted it will be the first time that an unlined tunnel has been used to carry water under an appreciable head.

By last autumn a length of 0·4km out of the total length of 5·3 kilometres of the tunnel from Sambuco to Peccia had been driven, and progress in driving the tunnel from Peccia to Cavergno amounted to 2·2km (total length 6·3km). The various side stream intakes shown on Fig. 45 are also under construction, and the tunnels which they involve were then 10 per cent completed. All of the tunnelling work will be completed by July, 1955.

Peccia and Cavergno Power Stations

The designs for Peccia and Cavergno power stations show considerable similarity ; the principal data for both of them are given in Table XI, and the diagrammatic cross section (Fig. 47) shows their general layout. The design of these power stations is based on the excavation of a single chamber of vaulted cross section, which is a good shape from the point of view of the stability of the rock. As will be seen, the main machine sets are situated in the centre of the chamber. The separate enclosures necessary for the valves and transformers respectively, which in other underground power stations, have involved the excavation of additional chambers, are formed by two substantial reinforced concrete walls which run the full length of the chamber and carry along their tops the crane rails for the machine room crane. Thus a very compact design has been achieved, within the diameter of about 27m of the chamber, and with consequent economy in excavation. The length of the chamber depends, of course, on the number of machines to be installed. At Peccia there are two pumps (see Table XI), which can be used in the summer to pump water from the

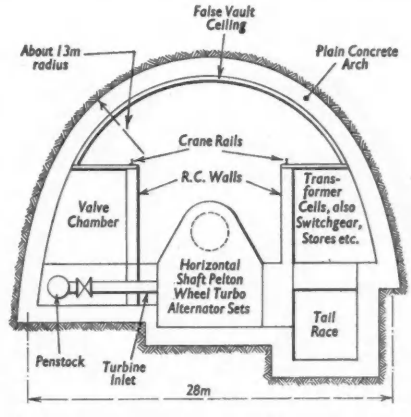


Fig. 47—Diagrammatic cross section of Peccia and Cavergno power stations

tail-race up to Sambuco reservoir. They are to be placed at the centre of the machine room, similarly to the turbines. Four single-phase transformers will be installed in the power station, to form one three-phase, 56MVA, 12/225kV group, with one stand-by.

The table shows that the gross head for Peccia power station is 426m, which for the most modern practice is within the range of head suitable for both Francis and Pelton

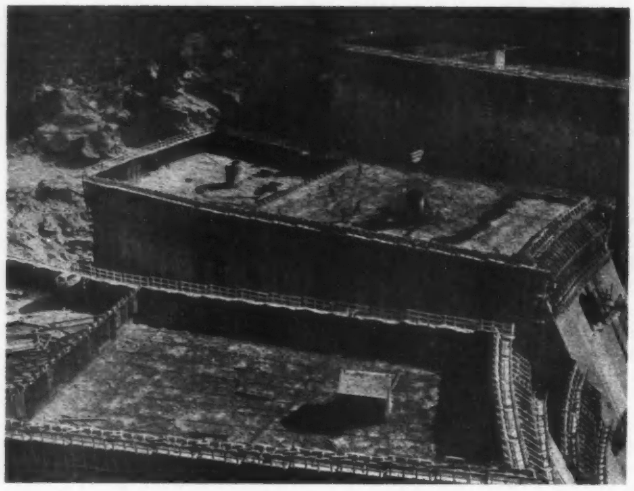


Fig. 48—Concreting in progress at Sambuco dam

Fig. 49—Excavation of rock "dumpling" at Peccia power station, after concreting arch

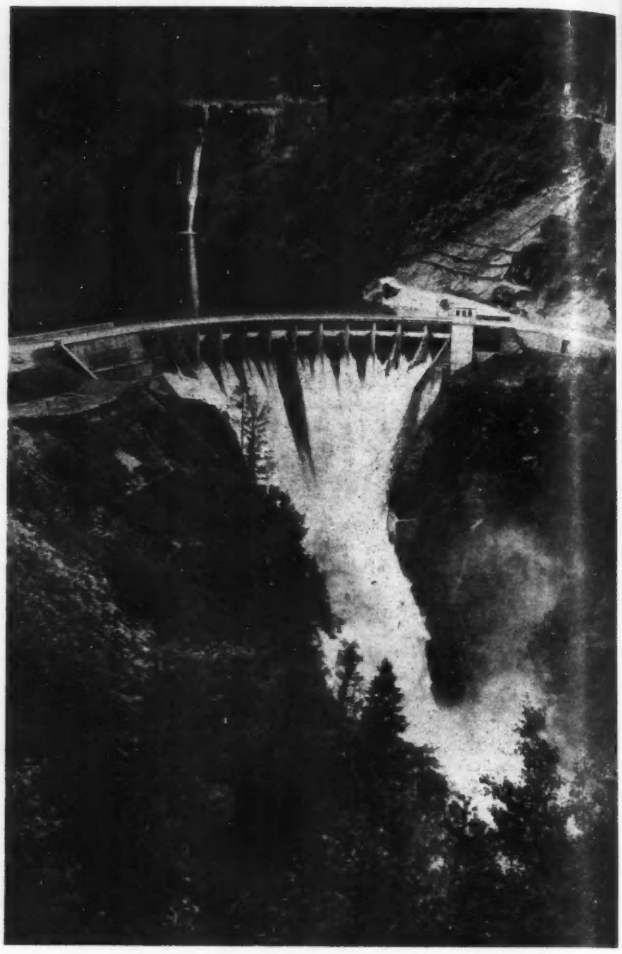


Fig. 50—Palagnedra dam

turbines. Generally, the trend is to use the Francis turbine for higher heads, and it is encroaching on the domains of the Pelton wheel; for instance, at Fionnay power station of the Mauvoisin scheme, Francis turbines are to be installed under a gross head of 459m. There are various advantages which the Francis machine now offers under such a head. However, it will be noted from the table that both Peccia and Cavergno power stations have horizontal shaft turbo-alternator sets, each consisting of an alternator driven by two Pelton wheel turbines, one on each side of it. The power station layout described above, with the single semi-circular chamber, is particularly suited to these machines, which require low head-room and have relatively compact mechanical and hydraulic layouts. Thus the maximum economy can be obtained when they are used and the chamber size kept to a minimum.

Peccia power station is shown under construction and in plan in Figs. 49 and 51; the general layout of the various access works, auxiliary installations, and so on, may be noted. It may be observed that the river has been diverted to allow the construction of a small reservoir to give the necessary storage for adjusting the flow to Cavergno power station. The reservoir banks are being formed from the spoil from the tunnelling works, which will be compacted and then faced with concrete slabs. The power station tail-race has a connection with this reservoir, but also leads to an inverted syphon passing under the river bed to a reinforced concrete aqueduct, which crosses the flat land forming the bottom of the valley and then joins with the diversion tunnel to Cavergno power station. The layout of the power station includes the tunnel marked "Corgello intake" in Fig. 51, which brings the waters of a small stream into the system. There is a small reservoir at the end of this tunnel, formed by enlarging the tunnel, and the water stored in it may be utilised as cooling water in the power station; alternatively, it supplies the intake for the pumps. The tunnel leading directly into the bed of the river may also be noted. This tunnel will serve as an emergency discharge from the valve chamber. It is the practice in most underground power stations to provide such an emergency discharge where it can be utilised in the event of a failure of a valve, and thus prevent the machine room from being flooded. The tunnel also forms the discharge outlet of a siphon, leading from the tail-race close to the machine outlets. Should the tail water rise above a given level, the siphon will start to function and hence keep the tail-race level down to a given figure. The surge shaft layout is similar to that at Verbano, described further on.

Cavergno power station is generally similar to Peccia. Its outlet works also include an inverted siphon, passing under the Bavona River, and an intake from that river to the free-flow tunnel of the lower stage works. It is expected that the first machines at both power stations will be in operation by July, 1955.

The Lower Stage Works

We now come to the lower stage works of the scheme, which are centred on the base-load power station of Verbano, and which, it will be recalled, are now substantially completed. Briefly, these works consist of the free-flow tunnel extending from Cavergno for a distance of 23km under the mountains on the right bank of the Maggia, and incorporating intakes and intake tunnels from four subsidiary streams, in addition to the various subsidiary intakes at Cavergno indicated on Fig. 45; a reservoir at Palagnedra in the Melezza valley, with storage of $4{\cdot}5\times10^6$ cubic metres (Fig. 50); a pressure tunnel from the reservoir; and the power station.

Verbano power station is similar in its general layout to the Innertkirchen power station of the Oberhasli company, but it contains vertical-shaft Francis turbo-alternator sets. The maximum gross head is 297m, and all four of the machine sets are now in operation. The tail-race, which leads into Lake Maggiore, is subject to fluctuations in level of about 10m, and a loss of head was avoided by the use of Francis machines.

The control room of Verbano power station incorporates the complete control of all the water intakes from Cavergno to Verbano. Thus, in operation, the Palagnedra reservoir is now generally kept full, and any excess of flow is rejected at the side stream intakes, where there are no reservoirs, and spilling of water over the spillway of Palagnedra dam is kept to a minimum. However, a good degree of utilisation of water from the side stream intakes will be obtained when the upper works are in operation by making full use of the intakes and drawing down the reservoir to make up any deficiency, when Cavergno power station is not in operation.

The four vertical-shaft Francis turbines

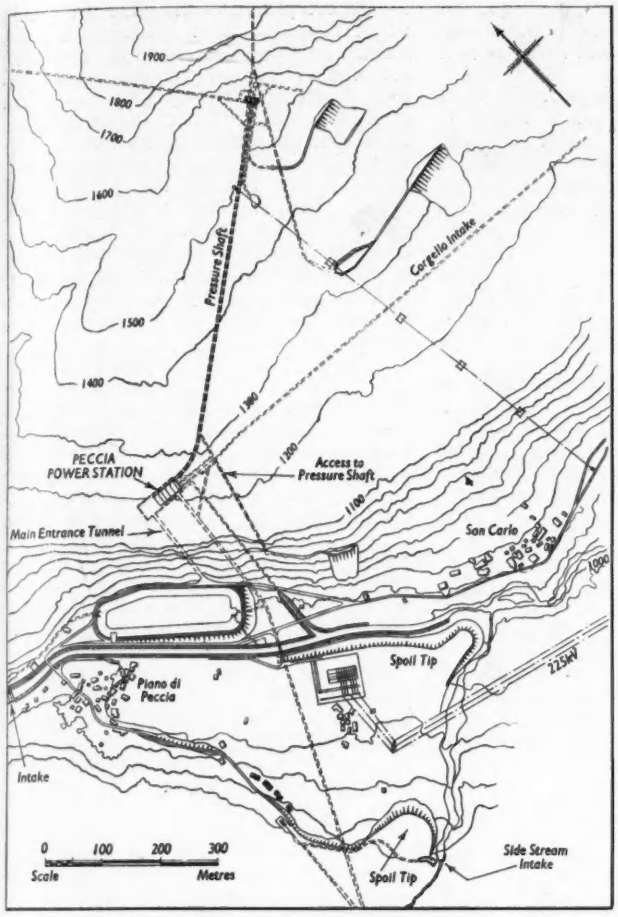


Fig. 51—Site layout at Peccia power station

each have a rated flow of 11 cumecs at 600 r.p.m. to give a rated output of 25·15MW. The alternators are 32MVA machines, generating at 12kV. There are seven single-phase, 12/225kV transformers in the power station, grouped in two sets of three, each set being of 64MVA capacity and serving two turbo-alternator sets, with one standby transformer. The transformers are situated in chambers alongside the main machine hall, from which they may be sealed off by fireproof doors. The power station auxiliaries include a standby diesel generating set and standby batteries which are housed on the surface in a maintenance building erected beside the road running along the shore of Lake Maggiore.

The power station has a false vault forming the ceiling of the machine hall, as is common practice with underground power stations, the enclosed space thus formed being used as a return duct for the air-conditioning system. The ceiling and walls of the machine hall are faced with asbestos cement sheeting, which has been selected as the most suitable noise-absorbing material for this purpose. Concealed lighting is also employed in the machine hall, giving it a pleasant appearance.

We have already described the methods adopted in the design and construction of the inclined pressure shaft at Verbano, in Part IX of this series, where these shafts were discussed generally. It may be recalled that the anti-corrosive metal spray and paint treatment were applied to the steel liner of the shaft in the factory, and the liner sections were welded together *in situ* and the welds radiographically tested. The arrangement where the pressure shaft joins the tunnel closely resembles the method used at Innertkirchen (referred to in Part IX). A surge shaft 11m in diameter rises vertically for 83m above the tunnel, which has a diameter of 3·75m (rated flow 44 cumecs) and is lined with steel from a point 80m upstream from the surge shaft. At the top of the surge shaft there is an expansion chamber. The throat between the surge shaft and the tunnel consists simply of perforations in the steel lining of the tunnel.

The tunnel continues in the same direction downstream from its junction with the surge shaft, until it joins the inclined pressure shaft; a butterfly valve is incorporated between these two points to control the flow in the tunnel. The inclined shaft continues upwards, above its junction with the tunnel, in the same straight line. Two manometers have been installed, one at the bottom of the surge shaft and one in the inclined shaft just above its junction with the tunnel, so that it will be possible to check the surge calculations under conditions of actual operation. A third manometer has been installed at the screens of the reservoir intake, to measure the head lost by the screens.

The surge arrangements at all three power stations of the scheme are to be very similar, but there is an interesting point in the design of the Peccia surge shaft, where one of the side stream intakes leads directly into it. A circular weir is to be built round the periphery of the shaft, so that water will discharge into it with the minimum of air entrainment. Model tests were carried out to ascertain the minimum depth of water which had to be present in the shaft to prevent air being carried into the tunnel, due to entrainment from the inflow over the weir.

Side-Stream Intakes

The free-flow tunnel from Cavergno to Palagnedra reservoir has a length of 23km and is largely unlined. It is approximately rectangular in cross section, with a vaulted roof. In cross section it is 5m wide and

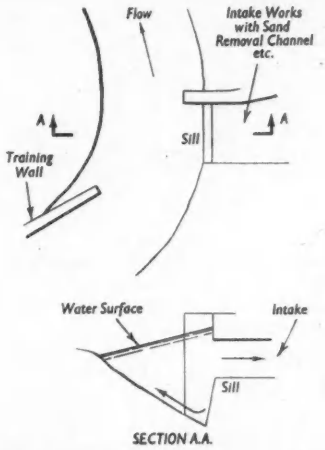


Fig. 53—Diagram of side-stream intake

3·3m deep to the springing of the vault, which is at about the normal surface level of the water in the tunnel.

The various side-stream intakes of the scheme, several of which lead into this tunnel, have all been designed according to a series of hydraulic model tests, carried out to find the form of intake which would reject solids of the sizes rolled down by the rivers. These intakes make use of a principle that has been applied for this very same purpose, though on a larger scale and hence with some degree of difference, on other hydraulic works such as the intake to the Donzere-Mondragon power canal on the River Rhone. The principle is that a scouring action takes place on the outside of a curve of a river's course. In

Fig. 52—Valley of the Maggia River at the site of Sambuco dam

this case, however, the rivers are torrential in nature and the application was developed along the lines indicated in principle by the diagram, Fig. 53, after fairly extensive model tests.

The diagram shows that a typical intake is situated on the outside of a bend in the river and that the pier on the downstream side of the intake sill projects somewhat into the stream. It will be seen that the greatest depth of water is at the sill, decreasing fairly sharply across the stream. The effect of the intake is then so marked that the surface level of the stream is much lower on the side away from the intake than it is at the intake itself. The result is that, while water is drawn in over the sill from the top part of the stream, a strong transverse current is induced at the bottom level, from the sill towards the inside of the bend. This current takes with it all the gravel rolled down by the river. The effectiveness may be enhanced by the addition of a training wall on the inside of the bend, just upstream from the intake, and of course, the stream bed must be deepened, to the profile shown diagrammatically, close to the sill. The sand removal channels forming the next stage of the intake are of conventional design.

The various side-stream intakes have capacities up to some 15 cumecs. The intake on the Isorno River has a capacity of 8 cumecs ; on the Rovana, 10 cumecs may be diverted ; and at Cavergno 15 cumecs may be obtained from the Bavona River alone. Thus, at times of high flow, three-quarters of the rated flow of Verbano power station may be obtained from the side stream intakes of the free flow tunnel.

Palagnedra reservoir is formed by a gravity dam which rises to a maximum height of 72m, and is arched in plan. The entire crest length of 120m is utilised as a spillway and the spillway bucket at the toe is divided into two parts by a training wall in the centre, which diverts the spillway discharge away from the right bank into the bed of the river. There is a drop of about 15m from the spillway bucket to the river bed, and the bottom part of the dam forms a plug in this steep and narrow part of the valley.

On the right bank side there exists a former river bed, filled with alluvial deposits, and a cut-off wall has been built to seal it. The wall was built in stages of cellular concrete construction, in a trench, in a manner very similar to the cut-off wall of the Marmorera dam.

Our thanks are due to the seven power companies listed in Part I of this series of articles, for their co-operation, which made possible the descriptions of their works. Our thanks are also due to the Schweizerischer Wasserwirtschaftsverband for its assistance, and to the consulting engineers for the Birsfelden scheme, Ingenieurbureau A. Aegerter and Dr. O. Bosshardt.

Boiler Water Specifications

By T. HENRY TURNER, M.Sc., M.I.Mech.E., M.I.Loco.E., F.I.M.

The first stage of B.S.I. work undertaken at the request of Lloyd's Register in 1942 *has been completed by the publication of two further specifications. Wide use of these is recommended to all boiler users. Periodical revision is envisaged, but these specifications are considered to offer a service unavailable a decade ago and greatly strengthen the control of boiler water treatment. Increasing costs of boiler cleaning, repair and replacement, the requirements of fuel economy, and continued serviceability make boiler water control essential. Corrosion and scaling of steam boilers can be prevented by disciplined routine control, using standard methods of boiler water sampling, analysis and treatment. The interpretation of test figures and the choice of suitable tests has now been facilitated by the production of this series of British Standard Specifications.*

A NOTABLE stage has been reached in the work of the British Standards Institution on boiler water tests and treatment, which was commenced a dozen years ago. The publication of two more standards dealing with various aspects of boiler water treatment brings to completion the first part of the work suggested by the present writer in a paper to the Institution of Mechanical Engineers.* The work consequently undertaken by the British Standards Institution, at the request of Lloyd's Register of Shipping, has resulted in the production of the following five standards.

"*Methods of Sampling Water Used in Steam Generation*," *B.S.* 1328 : 1946.—These methods of sampling water are fundamental to all and every kind of controlled boiler water treatment. They are applicable to natural raw water supplies, softened or otherwise treated waters, and also to concentrates taken from boilers. In the case of samples of boiler concentrates, the methods are satisfactory for boilers operating up to 500 lb per square inch, but may need modification for boilers operating at higher pressures. Only if engineers and chemists co-operate in using methods of sampling such as these will representative and reliable analyses be possible of the various waters which they have to control, namely, raw water, softened water, treated water, condensate, jet condenser water, feed water, boiler water, and distillate. After service for seven years this standard is under revision and the Committee intends to widen its scope to be "Sampling of Water Used in Industry." The sampling of steam is also under consideration.

"*Tests for Water Used in Steam Generation*" (*Group A Control Tests*), *B.S.* 1427 : 1949.—The main purpose of these standards is to ensure the maximum degree of uniformity in the methods of making the tests and in the manner of expressing the results. Originally it was planned to tackle this portion of the work in three stages.

(A) Control tests for which no laboratory is required: because in the early stages of the work one had in mind marine boilers.

(B) Laboratory tests such as could be carried out by any normal works control chemical analysts ; and

(C) Special tests for investigation purposes.

The present standard covers the group (A) tests and it was published without waiting for the completion of the other two groups which depended upon unfinished research work. However, the tests of this group (A) are of a simple character and can be performed where laboratory facilities are not available. The first part of the standard deals with the simple control tests and the second part covers some of the more difficult control tests. For the last five years an editing panel has been working on more elaborate tests which may be required and these were issued to industry for comment in 1953 and more recently submitted for approval for printing as Draft British Standard for "Methods for the Testing of Water Used in Industry."

"*Treatment of Water for Marine Boilers*," *B.S.* 1170 : 1947.—This standard was intended as an introduction to water treatment for marine boilers. The severe conditions imposed by the war caused trouble and delay, particularly to cargo steamers, owing to leaky tubes and distorted furnaces. The defects were largely due to the accumulation of boiler scale which resulted from the greater length of voyages in convoy, lessened facilities and time for repairs and removal of the scale, and from local dearth of replacement tubes, especially at ports abroad. Engineers accepted the advice that greater attention to well-established principles of boiler management combined with chemical treatment of boiler water on modern lines could reduce or completely remedy these troubles. The standard was therefore written under two heads, namely :

(*a*) Engineering factors.
(*b*) Chemical factors.

It described the method of boiler water treatment by which scale and corrosion-forming salts are destroyed by alkaline reagents with or without the use of an organic coagulant. It was found to be convenient to divide the make-up waters into three classes and the boilers into water tube and Scotch marine types, when recommending the chemical treatments. The five appendices and, in particular, the appendix dealing with abbreviations, definitions, equivalents and conversion factors have proved most helpful. After service for seven years this standard is under revision.

"*Methods of Sampling and Testing Boiler Water Deposits*," *B.S.* 2455 : 1954.—This standard is complementary to B.S. 1328 and B.S. 1427, which made possible for the first time the easy direct comparison between the findings of different samplers and analysts of boiler waters. In this case the object was the same, but it applied not to the waters, but to the large variety of deposits which are formed from the waters in the various parts of the equipment concerned with the generation and use of steam. They may be mineral deposits, sludge, scale, corrosion product, film or oily deposit. Here, however, one standard includes three sections in which the terms used are explained and methods are recommended for collecting and describing samples of deposits for their chemical and physical examination, and for reporting the results obtained so that they may be uniformly interpreted.

"*Treatment of Water for Land Boilers*," *B.S.* 2486 : 1954.—This standard is particularly directed to the needs of operators of steam generating plant, as used widely in industry and usually operated at a pressure not exceeding 250 lb per square inch. There are many relatively simple methods of water treatment, the use of which will ensure freedom from scale as well as protection of the boiler from corrosion.

There are three appendices : (*a*) Some reactions involved in water softening processes ; (*b*) relationship between methods of

* *Proceedings of the Institution of Mechanical Engineers*, Volume 148, July-December, 1942, pages 74–88, "Corrosion of Boiler Tubes," by T. Henry Turner. See page 81 : Recommendation (*d*) (1) "Simplify and standardise boiler water control tests as much as possible, with the aid of representative boiler users, I.C.I., Ltd., and the British Standards Institution," and also see Recommendation (*d*) (2) "Use boiler water control tests as part of the normal routine for all boilers." A suggested outline for British Standard Specification for boiler water tests was also given on pages 82 and 84.

expressing hardness of water; and (*c*) glossary of terms. They will save the time of many users of these standards.

Suggestions are tabulated for the chemical composition of feed water and boiler water for boiler pressures up to 250 lb. per square inch and also between 250 lb. and 600 lb per square inch. Above that pressure it was thought to be premature to attempt standardisation.

These very helpful standards are the product of sub-committees and panels on which official representatives of the largest owners of boilers, such as the Admiralty, the British Electricity Authority, and British Railways, have served, together with official representatives of the leading chemical manufacturers, water treatment chemists, marine engineering superintendents and boiler manufacturers. In many cases laboratory experiments and check tests on boilers have been carried out in the numerous laboratories and plants associated with the members of these sub-committees and panels before they agreed to the final wording. In some cases the need for effecting a compromise between different viewpoints may have tended to make the final drafts more conservative than one would have liked. It should be stated, however, without any fear of contradiction that this series of British Standard Specifications has in some cases proved already to be invaluable to boiler users. They have done much to bring about a notable advance in the knowledge and art of practical boiler water treatment, which has been removed by them from many of the uncertainties of meaning which were common little more than a decade ago.

It is well to recall that this series of B.S.I. recommendations grew directly out of that serious threat to our national security which the corrosion of ships' boilers, of both merchant ships and naval vessels in convoys, caused in the earlier years of the 1939–45 war. The problem was taken to the Corrosion Committee of the Iron and Steel Institute, where Dr. S. F. Dorey, F.R.S., asked that a memorandum submitted by the present writer should be given to the Institution of Mechanical Engineers as a means of directing urgent attention to the problem, and this was done. The standard for the treatment of water for marine boilers, which the British Standards Institution consequently hurriedly produced in wartime, was carefully worked over by a committee of engineers and chemists after the war and reissued as B.S. 1170 in 1947. When seven years later the question as to whether that standard should be revised was considered, there was thought to be little in it that needed alteration, and it was found to be in use by the Ministry of Transport for the instruction of young marine engineers, who are taught to regard it as essential in their studies for their chief engineers' tickets. To be on the safe side, however, the B.S.I. set up a new sub-committee of engineers and chemists to revise in the light of recent advances and changes what had already proved to be a very useful publication.

Admiralty conditions of boiler operation are varied, but for many of their boilers ashore and afloat similar methods of boiler water control and chemical treatment have proved highly beneficial in keeping boilers clean and free from corrosion to a degree unknown with the former lime treatment.* During the decade in which these standards have been appearing boiler pressures and temperatures have increased and the British Electricity Authority has brought into existence the scientific control of boiler water on a nation-wide scale. In France the S.N.C.F. has virtually abolished locomotive boiler repairs by the logical development of comprehensive boiler water treatment for all its steam locomotives. British Railways have approved in principle similar chemical treatments for their locomotive boiler waters, but because of incomplete application and lack of intensive control they have not yet caught up with the French, whose proved success in this direction has been outstanding. The Corrosion Group of the Society of Chemical Industry held a symposium on caustic cracking in steam boilers on November 20, 1952, as a result of which the formerly so-called caustic embrittlement mysteries are better understood. The symposium, which grew out of this B.S.I. committee work, was especially valuable because there is no scientific society especially devoted to boiler water treatment.

Boiler water treatment experts have no accepted forum of their own. It may be timely, therefore, to direct attention to the question of how engineers, chemists, metallurgists, corrosionists and fuel economists should collaborate. They should do so in order to make known in the future to all boiler users the theories and practices which deserve recognition by boiler operators in order that their boilers and ancillary steam plant may be maintained free from boiler scale, corrosion and priming and of maximum economic utility. The five standards referred to above show that the B.S.I. has carried out a far-reaching piece of practical industrial research which should lead to the widespread adoption of money and manpower saving, improved methods of boiler operation. This is perhaps not the expected function of a standardising body but the B.S.I. saw the need and offered its facilities. Voluntary work by many experts and public spirited firms met all other expenses and the success of this system of nation-wide instruction on technical subjects may seem to be obvious. It would still appear, however, to be desirable that the organisation required to take over the development of better boiler water control and to ensure that the best advice is available to all types of boiler user be periodically considered. The subject should perhaps become the accepted field of a new specialist group of the Society of Chemical Industry or of the Institution of Mechanical Engineers so that a forum could be provided and helpful publication aided.

Boiler water specifications will be an essential study for engineers for many years to come despite the development of diesel engines, gas turbines and atomic energy. The very high pressure water-tube boilers of the most modern electricity generating stations will pose boiler water treatment questions at present beyond the scope of B.S.I. standards. But these standards and their appendices and definitions are already a great help to engineers, chemists and metallurgists. When the writer first built up a team responsible for the treatment of boiler waters, for the locomotives, ships, power house, works and hotels of the former London and North Eastern Railway, the hardness of the waters was recorded by various writers in no less than seven different manners and there was no accepted order and method by which chemists should record their figures. The decisions of these B.S.I. committees, of which the present writer has acted as chairman, since the death of Dr. Guy Bengough, F.R.S., ten years ago, have led to the general use of methods of sampling, of analysis, and of setting out the chemists' reports, which greatly facilitate the comparison of one report with another.

The abbreviations, conversion factors and terms used in the treatment of boiler water set out in Appendix D of B.S. 1170 have already saved many chemists and engineers hours of work. The glossary of terms set out in Appendix C of B.S. 2486 published this year should help those in charge of the many boilers which provide the motive power for most industries in this country. So will also the neat summary of reactions involved in water softening processes given in Appendix A of that standard.

The British Standards Institution was pioneering when it set out to make available the best methods of sampling and testing, and methods of reporting analyses of boiler water deposits. The chemical composition and structure of boiler deposits vary in the same boiler according to its design and water circulation and temperature conditions. Now that the method of sampling, the method of preparing the sample for analysis and the methods of chemical and physical analyses are agreed engineers and chemists have for the first time common ground. The newly standardised method of reporting and interpretation of results will make the comparison of boiler water deposits more readily possible. Once these methods of investigation are fully adopted it will be possible to subject boiler water and boiler deposit analyses figures to subsequent Hollerith punched card statistical analysis. The fields for such statistical analyses of the causes and conditions of boiler failures are varied and possibly only the largest owners will be able to apply them, such as the British Electricity Authority. There are, however, potential users of these British Standards in warship, liner, tanker, tramp and trawler; in railway ships, coastal shipping and dockyard small craft with their high pressure water-tube, medium pressure water-tube or relatively low pressure Scotch marine types of boiler. On land these standards should be used by engineers for electricity generating stations, Lancashire boilers in works, laundry boilers, steam locomotives, diesel engine cooling water and the train heating boilers of electric or diesel locomotives.

The fields in which this group of British Standards should be used with profit to the community and to the boiler owners are immense. The growing shortage and cost of labour for boiler cleaning and repair make it obviously desirable that the need for boiler cleaning and repair be abolished by the use of properly controlled boiler water treatment as made widely available by these B.S.I. publications. Much has been achieved in this direction during the last decade and owners of medium pressure and medium size boilers are now adequately informed. The standards have been less successful at the extremes. Scientifically controlled water treatment remains almost unknown to many engineers in charge of trawler and tramp ship boilers, laundry boilers and similar relatively small and low pressure boilers. The very high pressure water-tube boilers at the other end of the scale will still require to be regarded as experimental, so far as standardisation of their water treatment goes, for several years to come.

The production of these British Standards has been a pleasant piece of team work in which engineers, chemists and metallurgists have given generously of their time and experience. All of them agree that they have learnt from their colleagues during their collaboration and that none of them could, unaided, have produced such useful comprehensive and authoritative publications, as have resulted. If they are periodically revised their value should remain as long as boilers are used.

* *Proc. I.Mech.E.* Vol. 160. July-December, 1949, pages 341-358. "Marine Boiler Deterioration" by I. G. Slater and N. L. Parr.

Hydrodynamic Lubrication of Roller Bearings

By W. LEWICKI

The classical theory of viscous flow is applied to elastically deformed surfaces in order to establish physical criteria for the existence of fluid wedge lubrication in the cylindrical roller bearing. Approximate algebraic solution for moderate to heavy specific load is given, according to which the Hertzian flats are set at an angle so that the pressure zone takes the form of a convergent fluid wedge, giving rise to a continuous fluid film of appreciable thickness independent of load. As a corollary approximate laws of rolling friction are deduced in terms of fundamental units.

Introduction

UNTIL the present day the mathematical problem of rolling bearings has never been solved, algebraically or numerically, in exact terms of simultaneous hydrodynamic and elastic differential equations. However, an ultimate conclusion reached on the basis of the present approximate solution is that such an exact solution is not of any urgent need. It becomes apparent that some of the essential facts known about the lubrication and wear of rolling bearings can not be accounted for in terms of these classical theories at all ; with respect to some other facts such an exact solution would still be a rather hazy over-simplification, a long-winded one at that. For these reasons it seems just as well to use the present approximation, which at least is very concise.

There seems to be a widespread belief (Michell, pages 213, 223, 235 ; Lane, page 37 ; Clayton, page 26 ; Howlett, page 137)* that no continuous fluid film can exist between rolling elements, even moderately compressed, a belief probably originated by Reynolds (1875) in his famous experiments with rollers on an inclined plane. The fact that an electric current may pass between the elements of a rolling bearing or between gears is often taken to prove that the actual solid contact exists. However, the films in question are of the order of 10 micro-inches and a potential difference of few volts would easily precipitate field emission and cause a virtual disappearance of the electric resistance in the fluid layer by the so-called tunnel effect. Field emission normally occurs with an electrostatic field intensity in the neighbourhood of 10^6 volts per centimetre ; it can set on spontaneously at a much lower field strength by various causes, such as, for example, local concentrations of field on the surface asperities, electrostatic potentials induced within the lubricant by its motion, metallic dust or other lubricant contaminations.

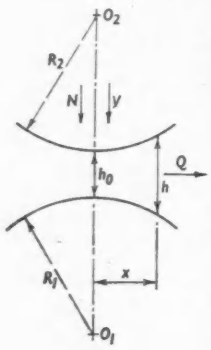


Fig. 1

The belief in the non-existence of a continuous fluid film between lubricated rolling surfaces is also supported on theoretical grounds by mathematical arguments such as the Michell's (Michell, pages 299–301). The latter argument is reproduced here below in a slightly simplified form and its fallacy is shown by way of cross-checking the end formulæ.

Michell's Theory.—Consider two parallel rigid cylinders at a small distance apart with the interspace filled with an incompressible fluid ; the cylinders do not rotate or slide, but approach one another centrally under an external load, so that at some instant t their relative velocity is V and their distance h_0 (see Fig. 1 and the list of symbols). Then the differential equation

$$\frac{d}{dx}\left(\frac{h^3}{\eta}\frac{dp}{dx}\right)+12V=0 \quad . \quad . \quad . \quad (1)$$

describes one-dimensional flow with viscous effects predominating, provided that the length of the cylinders is sufficiently large, and the distance h_0 sufficiently small, compared with the diameter. It should be noted that the equation (1) incorporates the principle of the continuity of flow through the relation

$$V\equiv -dh_0/dt=dQ/dx \quad . \quad . \quad (1a)$$

Assuming constant viscosity this can be integrated directly to give

$$dp/dx=-12\eta Vx/h^3 \quad . \quad . \quad . \quad . \quad . \quad (2)$$

the flow being symmetrical.

For the convenience of integration to infinity, suppose that the cylinders are replaced by infinite parabolic surfaces with the same radii of curvature at their apex. It can easily be shown that this does not introduce any appreciable error in this analysis, but makes it more concise. Now the film thickness is

$$h=h_0+Kx^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Assuming $p_\infty=0$, and integrating to infinity,

$$p=3\eta V/Kh^2 \text{ and } p_0=3\eta V/Kh_0^2 \quad . \quad . \quad (4)$$

The magnitude of external load is found by a further integration

$$N=\int_{-\infty}^{+\infty} pdx=3\pi\eta V/2(Kh_0)^{3/2} \quad . \quad . \quad . \quad . \quad (5)$$

Knowing this the time of approach can be shown to be

$$t_{1-0}=-\int_{h'_0}^{h_0} dh_0/V=\frac{3\pi\eta}{NK^{3/2}}(1/\sqrt{h_0}-1/\sqrt{h'_0}) \quad . \quad . \quad . \quad . \quad . \quad (6)$$

This is where Michell ends his analysis and he draws his conclusions from (6). However, eliminating V between (4) and (5),

$$p_0=\frac{2N}{\pi}\sqrt{\frac{K}{h_0}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

showing that the notion of the solid contact under the assumed conditions relies in fact on generating an infinite fluid pressure at a point. The latter being impracticable, it makes it questionable whether a solid contact is at all feasible. A further insight into the mechanism of what really happens can be obtained by way of examining the following specific case : two rigid cylinders of diameter 2in and 8in respectively are immersed in a fluid of viscosity $\eta=1$ poise and loaded 1000 lb per inch of their length. Time lapses for $h'_0=10^{-3}$in and peaks of pressure generated are calculated from (6) and (7) and shown in Table I below.

Table I

h_0, inches	t_{1-0}, seconds	p_0, pounds per square inch
10^{-3}	0	16,000
10^{-4}	19×10^{-6}	50,000
10^{-5}	79×10^{-6}	159,000
10^{-6}	268×10^{-6}	504,000

From the numerical values above it can be appreciated that long before the film can be regarded on some practical considerations as broken the concentration of pressure becomes such that no material substance can sustain it. This example makes it clear that the apparently slight elastic deformation in reality must be enough to prevent any such extreme unevenness of pressure distribution and to bring its maximum sufficiently down to make it more or less in line with the Hertzian specific stress ; it is a matter of common experience that the Hertzian theory is applicable to the case, and the Hertzian specific stress for steel cylinders in the above example has a moderate value of 81,000 lb per square inch.

Equations (5), (6) and (7) show together that when the curvature K is locally diminished by surface deformation the fluid pressure becomes more evenly distributed and the time of approach is lengthened. This is only a qualifying argument ; it becomes still more obvious and informative by way of a similar analysis for spheres : it can be shown that for spheres

$$t_{1-0}=3\pi\eta/2K^2N \,.\, \log_e \,.\, h'_0/h_0 \quad . \quad (8)$$

$$p_0=KN/\pi h_0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

Table II below shows the peak pressure generated and the time lapses in the course of approach for an equivalent case to the first example, with cylinders replaced by spheres of the same diameter and loaded to 1000 lb.

Table II

h_0, inches	t_{1-0}, seconds	p_0, pounds per square inch
10^{-3}	0	200,000
10^{-4}	$0{\cdot}4\times10^{-6}$	2,000,000
10^{-5}	$0{\cdot}8\times10^{-6}$	20,000,000
10^{-6}	$1{\cdot}2\times10^{-6}$	200,000,000

Spheres are seen to generate an extraordinarily acute peak of pressure and in view of the foregoing remarks the exceedingly short time-lapses found cannot correspond to reality in any reasonable degree of approximation. It is conceivable that the elastically deformed region or the so-called Hertzian pressure zone in actual fact acquires an inward curvature ; in this way a lens-shaped pocket of fluid would form, acting as a hydraulic cushion. The time lapses would automatically extend, beyond comparison.

However, Michell uses the figures of the Table II as a direct proof that the lubricant film is pierced almost instantly on the application of a load.

Other Theories of Gear Lubrication.—Earlier theories, such as Martin's (1916), Karlson's (1929), Gatcombe's (1945, 1949) and Hersey and Lowdenslager's (1950), all neglect elastic deformations ; they are all questionable on the same ground as the

Symbols

b = Width of flats.
c = Angle of convergence of fluid wedge.
E = Young's modulus.
f = Force of friction.
h = Lubricant film thickness.
k = Constant of integration.
$K=(1/R_1+1/R_2)/2$, mean curvature.
N = Load per unit length.
P = Hertzian specific (compressive) stress.
p = Fluid pressure.
R = Radius of curvature.
Q = Volume rate of flow.
S = Restoring (elastic) force component.
t = Time.
T = Total viscous drag.
U = Surface velocity of rolling.
V = Relative velocity of approach.
x, y, z, a, l = Co-ordinates.
$\alpha=h_2/h_1$, film ratio.
δ = Centre of pressure distance.
η = Absolute viscosity.
μ = Coefficient of rolling friction.
σ = Poisson's ratio.
τ = Fluid shear stress.
θ = Angle.

* Numbers refer to the pages of the references listed at the end of this article.

Michell's theory. More recent theories, such as, for example, the Clayton's extreme pressure boundary lubrication theory (1950), seem to have grown from the concept already discussed that the lubricant is almost entirely squeezed out from the contact zone; they all imply a substantial surface wear and, of course, cannot tell why or when the state of complete lubrication exists. In point of

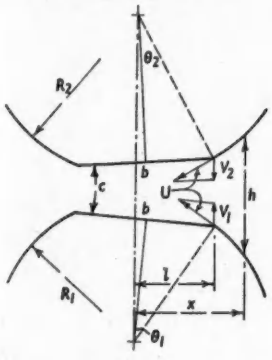


Fig. 2

fact cases are known of gears having operated under fully loaded conditions for as long as twenty years and yet still showing some of the original machining marks on their teeth, evidence of the virtual absence of surface wear.

Only Weber, in his unpublished paper (1949), not available when the present analysis was devised, gives some mixed solutions (analytical and numerical) of the combined hydrodynamic and elastic action from the standpoint of the classical theories. However, his results so far apply to exceedingly small loads, much below the region useful for rolling bearings and gears.

Approximation Proposed

In considering the case of cylindrical surfaces in the state of pure rolling (e.g. with no sliding present) for the constant viscosity and constant density lubricant the procedure adopted is as follows :—At the outset the state of hydrodynamic and elastic equilibrium is assumed and its geometry is taken to be that of Fig. 2, whose parameters are then adjusted to fit the Reynolds and Hertzian equations.

In the adopted frame of reference the two axes of rotation and the pressure zone are all fixed in space. It should be pointed out that the transition points between the flat and the curved surface are in fact quite imperceptible due to the smallness of b and they do not involve anything like the sharp edges shown.

(*a*) *Pressure Generated on Curved Surfaces.*—The film thickness in the region adjacent to the flats is

$$h=h_2+K(x^2-l^2) \quad . \quad . \quad . \quad . \quad . \quad (10)$$

As the convergence c is very small, ordinarily of the order of 0·001, the above can be replaced by

$$h=h_2+K(x^2-b^2/4) \quad . \quad . \quad . \quad . \quad (11)$$

without introducing any appreciable error. At the point $x=l$ the velocity of approach is

$$V=U\sin\theta_1+U\sin\theta_2\cong KUb \quad . \quad (12)$$

In order to make the differential equation (1) directly applicable assume that V is constant all along the curved surface. In other words, imagine for a moment that rotation U is replaced by the translation V. In addition, take $Q_0=0$, as in fact the flow caused by the assumed translation will be nearly symmetrical. These assumptions produce the solution of (1) in the form equivalent to (4), namely,

$$p_l=3\eta Ub/h_2^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

Using more exact methods it can be shown that (13) somewhat underestimates the magnitude of p_l.

(*b*) *Pressure Along Flats.*—Replacing again the surface velocities by their relative approach component we have

$$V=U\sin\theta_1+U\sin\theta_2\cong Uc \quad . \quad . \quad (14)$$

The film thickness in the co-ordinate system of Fig. 3 being $h=cx$, the equation (1) gives

$$p=12\eta U\,.\,(1/x-x_m/2x^2+k)/c^2 \quad (15)$$

with $dp/dx=0$ at $x=x_m$. The constants of integration x_m and k can be determined from the boundary conditions $p_{a_1}=0$ and the result (13). Actually, some suction is likely at $x=x_1$, but ordinarily it should not greatly exceed 1 atmosphere (although theoretically up to about 900 atmospheres suction may develop), and it could not measurably affect the result when the mean pressure along the flats is of the order of 10,000 atmospheres.

Introducing the notion of film ratio $\alpha=h_2/h_1$ and changing the variable to $y=(x-a_1)/b$, the pressure within the film at any point along the flats becomes

$$p=\frac{3\eta Ub\{4\alpha-3y(\alpha-1)-2\}y}{h_1^2(\alpha+1)\{1+y(\alpha-1)\}^2} \quad . \quad (16)$$

giving a somewhat asymmetrical pressure distribution, with its maximum at $y=(\alpha-\frac{1}{2})/(\alpha^2-1)$, and so the extent of its

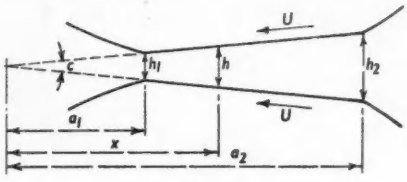


Fig. 3

asymmetry being dependent on α alone; an example is given in Fig. 7.

The total load carrying capacity follows from (16) thus :

$$N=\int_{a_1}^{a_2}p\,dx=\frac{12\eta Ub^2\left\{\log_e\alpha-\dfrac{(\alpha-1)(7\alpha+1)}{4\alpha(\alpha+1)}\right\}}{h_1^2(\alpha-1)^2} \quad . \quad . \quad . \quad . \quad . \quad (17)$$

the contribution of the fluid pressure distributed along the curved surfaces being negligible ordinarily, say, when the Hertzian specific stress exceeds 50,000 lb per square inch.

The centre of fluid pressure is found by method of moments thus :

$$x_N=\frac{1}{N}\int_{a_1}^{a_2}px\,dx \quad . \quad . \quad . \quad (18)$$

Its distance from the mid-point of the flats being $\delta=x_N-(a_1+a_2)/2$, it follows from (18) that it is

$$\delta=\frac{\dfrac{12\alpha+1}{8\alpha}-\left\{\dfrac{4\alpha+1}{4(\alpha^2-1)}+\dfrac{\alpha+1}{2(\alpha-1)}\right\}\log_e\alpha}{\log_e\alpha-\dfrac{(\alpha-1)(7\alpha+1)}{4\alpha(\alpha+1)}}\,b \quad . \quad . \quad . \quad . \quad . \quad (19)$$

from which it is found that $\delta=0$ when $\alpha=2\cdot618$. It can be anticipated that if there are no significant tangential forces on the flats this value of α is assumed spontaneously and as a matter of equilibrium; it is noteworthy that the equilibrium state would then be independent of both η and U.

(*c*) *Tangential Force on Flats.*—Fig. 4 depicts the relative motion of fluid with respect to the surface of flats and so it is applicable whether the cylinders are thought to translate centrally or to rotate. There is the relative outward flow both ways from the point along the flats where the fluid pressure is maximum ($x=x_m$). Hence there is a differential drag and the resultant tangential force is obviously small.

Using the well-known relation $\tau=-h\,.\,(dp/dx)/2$, valid for the laminar (viscous) flow in accordance with our assumptions, and putting into it dp/dx from (15) by

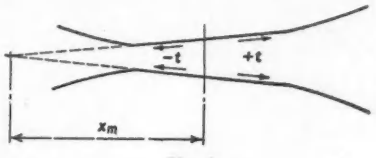


Fig. 4

differentiation, the total drag on one of the flats of Fig. 4 is

$$T=\int_{a_1}^{a_2}\tau\,dx=\frac{6U\eta b\left\{\log_e\alpha-\dfrac{(\alpha-1)(4\alpha+1)}{2\alpha(\alpha+1)}\right\}}{h_1(\alpha-1)} \quad . \quad . \quad . \quad . \quad . \quad (20)$$

It is found to nullify at $\alpha=2\cdot82$; at $\alpha=2\cdot618$ (i.e. when $\delta=0$) it is negative, or, in other words, it is then directed to help the rotation.

In order to analyse briefly the influence of T on the equilibrium value of α the following argument is used.

The flattened portion of each roller (Fig. 5) is regarded as a non-inertial body of constant length, free to displace, but held in equilibrium by two opposed turning moments, namely, δN and $Sb/2$, as shown in the figure. The S resolute of T is to be balanced by the non-viscous or normal pressure on the flat, so it must be perpendicular to the flat; the F resolute is chosen parallel to the end of the circular portion to balance the resulting tangential surface stress, on the assumption that there are no significant normal forces on the cylinders beyond their flats. From the Fig. 5

$$S_1=T\tan\theta_1\cong Tb/2R_1\;;\;\; S_2=T\tan\theta_2\cong Tb/2R_2 \quad . \quad . \quad . \quad . \quad . \quad (21)$$

for the cylinder shown and the other, respectively. The two forces resulting are seen to be uneven; this should lead to a shift of one flat in relation to the other. However, for the purpose of an overall effect on the convergence c it is assumed that the effective mean force

$$S=S_1+S_2/2=TKb/2 \quad . \quad . \quad . \quad (22)$$

acts equally on two flats. Hence, our equilibrium condition becomes

$$Sb/2\equiv TKb^2/4=\delta N \quad . \quad . \quad . \quad . \quad (23)$$

On substituting for T, δ, N, and ordering

$$4\log_e\alpha-\frac{4(\alpha^2-1)(12\alpha+1)+Kh_1(\alpha-1)^3(4\alpha+1)}{2\alpha(2\alpha^2+8\alpha+3)+Kh_1(\alpha^2-1)(\alpha-1)\alpha}=0 \quad . \quad . \quad . \quad . \quad . \quad (24)$$

which gives the equilibrium value of α. However, the non-dimensional factor Kh_1 is exceedingly small, usually of the order of 10^{-5}, and the terms containing it can be omitted without affecting the result in its fifth decimal place; if this is done the equation (24) becomes identical with the numerator of (19) =0. Hence, the previously found equilibrium value of α remains valid.

(*d*) *Criterion for Validity of Approximation.*—It is postulated that for a bulk state of equilibrium not only the mean fluid pressure should equal the mean compressive stress along the bounding surfaces, but also their respective maxima should equal. In other

words, the ratio maximum/mean fluid pressure should, in the present analysis, equal the Hertzian coefficient $4/\pi$.

From (16), for $\alpha=2\cdot618$,

$$p_{max}=\frac{3\eta Ub}{h_1^2}\frac{(2\alpha-1)^2}{(\alpha^2-1)(4\alpha+1)}=0\cdot8016\frac{\eta Ub}{h_1^2} \quad . \quad . \quad . \quad . \quad . \quad (25)$$

and from (17), again for $\alpha=2\cdot618$,

$$p_{mean}\equiv N/b=0\cdot6284\ \eta Ub/h_1^2 \quad . \quad (26)$$

hence their ratio

$$p_{max}/p_{min}=1\cdot2756 \quad . \quad . \quad . \quad . \quad (27)$$

which agrees with the Hertzian coefficient to 0·0025. In the present circumstances it is a very good agreement, which upholds the original assumption of straight flats. Fig. 7 shows the two curves superimposed; the Hertzian stress distribution being symmetrical, the asymmetrical curve is the fluid pressure distribution calculated from (16) for $\alpha=2\cdot618$.

(*e*) *Minimum Film Thickness.*—For cylinders in a dry contact the maximum (specific)

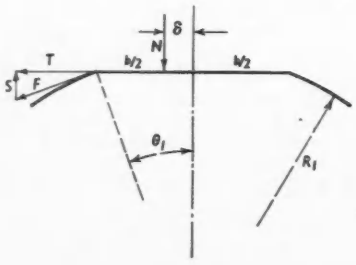


Fig. 5

compressive stress is, according to Hertz,

$$P\equiv p_{max}=KbE/4(1-\sigma^2) \quad . \quad . \quad (28)$$

Combining this with (16), we have

$$h_1=1\cdot791\sqrt{\frac{\eta U(1-\sigma^2)}{KE}} \quad . \quad . \quad (29)$$

This is an interesting result; it shows that the film thickness is (approximately) independent of load. It can be understood why it should be so; an increase of load will widen the elastic impression, thus providing an extra viscous resistance to outflow with which to counterbalance the added external impulse to outflow. It appears from (29) that the two effects exactly outbalance one another, and so have no effect on the film thickness and the film ratio.

The formula (29) is illustrated by the following numerical example: two heavily compressed steel cylinders are rolling against one another without sliding, the lubricant having a constant viscosity of 1 poise; elastic constants taken for steel are, the Poisson's ratio $\sigma=0\cdot3$ and the Young's modulus $E=30\cdot10^6$ lb per square inch. Surface velocity and diameter of the cylinders are varied while the ratio of the diameters is kept constant at 4 : 1. The calculated film thickness (29) is tabulated below.

TABLE III—*Minimum Film Thickness, Microinches*

Surface velocity, metres per second	Diameter of the smaller cylinder, inches					
	200	20	2	0·2	0·02	0·002
50	667	211	67	21	7	2
5	211	67	21	7	2	1
0·5	67	21	7	2	1	—
0·05	21	7	2	1	—	—
0·005	7	2	1	—	—	—

(*f*) *Coefficient of Rolling Friction.*—When a cylinder rolls on a flat surface without sliding and the external driving force f is applied to the axis of rotation as shown in Fig. 6, the solution in terms of normal forces, or pressure, is

$$f=cN+\int_{a_2}^{\infty}p\sin\psi\,d\chi\cong cN+2K\int_{a_2}^{\infty}px\,dx \quad . \quad (30)$$

Applying f along the interface and fixing the

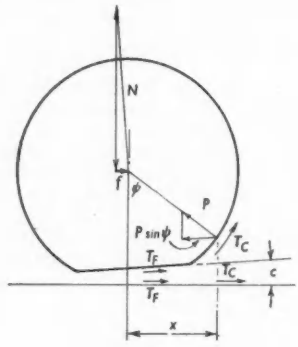


Fig. 6

axis of the cylinder in space, the solution in terms of viscous drag is

$$f=2T_F+2T_C \quad . \quad . \quad . \quad . \quad (31)$$

The integral of (30) is readily identified with

$$T_C=\int_{a_2}^{\infty}\tau dx=3\eta Ub/h_2 \quad . \quad . \quad (32)$$

This, incidentally, leads to an interesting result,

$$cN=T_C+2T_F \quad . \quad . \quad . \quad . \quad (33)$$

From Fig. 2 we have

$$c=(\alpha-1)\,.\,h_1/b \quad . \quad . \quad . \quad (34)$$

Substituting for N, T_f, c, from (17), (20) and (34), and ordering we have, in either case identically

$$f=\frac{12\eta Ub}{h_1}\left\{\frac{\log_e\alpha}{\alpha-1}-\frac{3}{2(\alpha+1)}\right\} \quad . \quad (35)$$

The coefficient of friction can be defined approximately as

$$\mu\cong\frac{f}{N}=\left\{\frac{\dfrac{\log_e\alpha}{\alpha-1}-\dfrac{3}{2(\alpha+1)}}{\dfrac{\log_e\alpha}{\alpha-1}-\dfrac{7\alpha+1}{4\alpha(\alpha+1)}}\right\}c \quad . \quad . \quad (36)$$

Substituting for c, h, b, from (34), (29), (28), and reducing the function of α to a constant by putting $\alpha=2\cdot618$, we finally have

$$\mu=\frac{1\cdot541}{P}\sqrt{\frac{U\eta KE}{1-\sigma^2}} \quad . \quad . \quad . \quad (37)$$

It is worth mentioning that if the above reasoning is somewhat perfected by adding

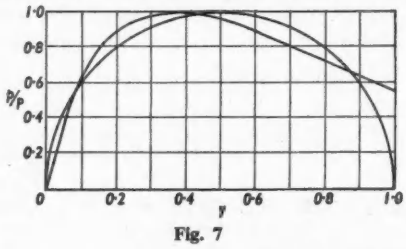


Fig. 7

the deflection of the plane the result (37) is obtained in a more roundabout way. It can easily be shown that (37) is also valid for the case of two cylinders rolling against one another.

The formula (37) is illustrated by the following numerical example: a heavily loaded cylinder of steel 2in in diameter rolls along a steel plane; the lubricant has a constant viscosity of 1 poise and the elastic constants for steel are the Poisson's ratio $\sigma=0\cdot3$, the Young's modulus $E=3\cdot10^7$ lb per square inch. Rolling velocity and the Hertzian specific stress are varied and the coefficients of rolling friction found from (37) are tabulated below.

TABLE IV—*Coefficient of Rolling Friction, Per Cent*

Hertzian specific stress, pounds per square inch	Rolling velocity, metres per second				
	50	5	0·5	0·05	0·005
50,000	2·10	0·67	0·21	0·07	0·02
100,000	1·05	0·33	0·11	0·03	0·01
150,000	0·70	0·22	0·07	0·02	0·01
200,000	0·53	0·17	0·05	0·02	0·01
250,000	0·42	0·13	0·04	0·01	—

It is noteworthy that Buckingham's empirical formula for the friction loss in spur gears of steel, which he incidentally ascribes to the sliding friction,

$$\mu=\frac{2}{3}\left\{\frac{0\cdot050}{e^{0\cdot125V_s}}+0\cdot002\sqrt{V_s}\right\} \quad . \quad (38)$$

is seen to contain the square root of sliding velocity V_s. However, V_s being in a given gear proportional to the rolling velocity and the exponential term being negligible for medium and high operating velocities, Buckingham's result is seen to be closely related to (37).

Conclusions.—It follows from the preceding discussion that in terms of the classical hydrodynamic theory the lubricant film virtually cannot be pierced through overloading or overspeeding; if in practice this does happen, the cause is foreign to these theories. There are, of course, many other well-known facts and clues pointing to the domain of heat effects for the solution of this apparent anomaly.

Provided that heat effects are kept sufficiently down, the grain size of the surface asperities decides whether or not the state of complete lubrication exists; it should not exceed, say, a half of the film thickness found from (29). It is quite probable that most of the successfully lubricated machine elements do actually operate on the principle of complete fluid separation, although the fundamental cause of success might have been introduced unconsciously or else empirically and as a matter of chance.

It is remarkable how slowly the film thickness varies over so wide a range of diameters (see Table III) and how relatively thick the film is with small diameters. It appears that, on the whole, the smaller the diameter the easier it is to obtain a complete fluid separation. This would explain, for instance, why needle bearings are often found more satisfactory than other types of rolling bearings.

The variation of the coefficient of rolling friction is also exceedingly slow (see Table IV). This is probably why, since Reynold's times (1875) it has often been taken for a constant.

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Orient Liner "Orsova"

The "Orsova," which joined the fleet of the Orient Steam Navigation Company, Ltd., earlier this year, has completed her maiden voyage to Australia and back. A total of 681 first-class passengers and 813 tourist passengers are accommodated and the ship has a gross registered tonnage of 28,790. The service speed of the liner is 22·5 knots, and is maintained by propelling machinery consisting of twin-screw geared turbines of 34,000 s.h.p. taking superheated steam at 500 lb per square inch and 850 deg. Fah. from three water-tube boilers.

THE Liner "Orsova," which was launched by Lady Anderson from the Barrow yard of Vickers-Armstrongs, Ltd., on May 14th of last year, completed trials earlier this year and sailed on her maiden voyage to Australia in the service of the Orient Line on March 17th. This ship is the second Orient liner to bear the name of "Orsova," a name which is taken from a small town on the Danube near to the Iron Gate, and so the ship has as her badge a watergate resembling an heraldic portcullis. The twin-screw turbine-driven liner was built and engined by Vickers-Armstrongs, Ltd., and bears a family likeness to the "Oronsay," which was built at Barrow in 1951. Both ships have practically identical dimensions, but the latest addition to the fleet has a modified bow and cruiser stern to give a slightly greater overall length, while other noteworthy differences are the distinctive funnel and the complete absence of anything resembling a mast.

"Orsova" has been constructed under the survey of and to the rules and regulations of Lloyd's Register of Shipping and embodies in her design the latest regulations of the Ministry of Transport. In conformity with the builder's practice, and to take full advantage of the modern facilities and layout of the shipyard, welding has been employed throughout and sections of the structure, weighing up to 50 tons, have been prefabricated and lifted into place on the building berth. Riveting has been limited to the strength deck stringer angle and to the stiffeners of certain of the deckhouses. To compensate for the loss of support to the shell plating occasioned by the elimination of the floor connecting angles, due to the adoption of welding, longitudinal stiffeners have been incorporated in the bottom structure. Decks "D," "E," "F" and "G" extend for the full length of the ship and also "C" deck, except for a break aft of the forecastle, while "A" and "B" decks form the super-structure. "H" deck extends forward and aft of the machinery spaces, while "J" deck forms an orlop deck in the three forward holds and also the tunnel top. There are eight decks for the passengers and crew with the first-class passengers occupying the 'midship lengths of decks "A," "B," "C," "D" and "E" and part of "F" deck forward of the casing. Tourist passenger accommodation is located aft on "C," "D," "E" and "F" decks and also takes in all of "G" deck aft of 'midships and "H" deck aft of the engine-room, while the officers and crew are accommodated in the bridges and occupy the forward portions of "C," "D," "E," "F" decks, "G" deck forward of 'midships and also the starboard side of "E" deck abreast the engine and boiler room casings.

Our photographs include an aerial view of the ship at speed and illustrations of the lounge, starboard galley, veranda bar, and dining room of the first-class accommodation, the tourist library and the laundry.

First-Class Accommodation

A wide variety of cabins, for the 681 first-class passengers, are arranged on the various decks, the majority being fitted with two berths, and a considerable number have private bathrooms or showers attached. There are a total of eighty single-berth cabins, mainly located on "C" and "D" decks and one special two-berth flat. The cabin walls and fore and aft alleyways are lined with "Vynide," in pale shades, and in the alleyways slatted ceilings serve to hide all piping and trunking, while a total of 123 cabins are air conditioned.

Sporting activities are catered for mainly on "A" deck, which has three separate areas laid out for games. Forward of the bridge there is the arena of some 4000 square feet, which has raised surrounds and protective windscreens, and aft of the funnel is the 'midship deck, which is designed as the social centre of the ship and equipped to stage open air cinema shows. Raised surrounds provide a viewpoint for spectators, for whom there is also a covered balcony aft of the funnel, while sliding side screens give protection from the winds. Further aft and raised about 9ft is the quoit tennis deck. At the forward end of this deck is the grand stand, to starboard amidships is a table tennis room and to port is the library. Right aft is the restaurant, which has glass divisions to form an ante-room and is decorated with coloured reproductions of pages from a scrapbook and is served from an adjoining kitchen.

Right forward on "B" deck and separated from the main deckhouse is the children's playroom, sand-pit and a paddling pool. A lobby at the forward end of the deckhouse gives access to the promenade space to port and starboard and also to the lounge, which has woodwork in English ash and painted walls and ceilings with the main decoration consisting of a mural representing the outside of a boat-house. Double swing doors open aft on to a lobby from which other sets of doors lead to galleries, arranged on either side of the boiler casing, in which the predominant colour is that associated with that particular side of the ship. Pictures in the modern style form the decorations of the galleries, which link the lounge with the square. This space is arranged for dancing and has gay bunting curtains, sliding glazed screens and also includes a cinema projection room. From the square there is direct access to the veranda

General Particulars

Length overall	722ft 9in
Length between perpendiculars	668ft
Breadth moulded	90ft 6in
Breadth maximum	93ft 6in
Depth moulded to "E" deck	50ft
Draught	30ft 9in
Service speed	22½ knots
Trial speed	26 knots
Refrigerated cargo, cubic feet	94,060
Gross registered tonnage	28,790

Accommodation

First-class passengers	681
Tourist "B" class passengers	813
Crew	645

Propelling Machinery

Type: Twin-screw, double-reduction geared Parsons turbines of Pametrada design
Normal power: 34,000 s.h.p. at 130 propeller r.p.m.
Overload power: 42,500 s.h.p. at 140 propeller r.p.m.
Astern power: 65 per cent of normal ahead power
Steam supply: 500 lb per square inch gauge at 850 deg. Fah.
Boilers: Three Foster Wheeler of controlled superheat design
Superheat range: 850 deg. Fah. down to 600 deg. Fah.
Steam pressure: 525 lb. per square inch at superheater outlet

Electrical Machinery

Type of generators: Three W. H. Allen turbo-generators
Rating: 1200kW, 220V d.c.
Overload: 1500kW for two hours
Emergency: Two W. H. Allen diesel-driven generators
Rating: 100kW, 220V d.c.

Passenger Liner "Orsova" for the Australian service of the Orient Steam Navigation Company, Ltd.

ORIENT LINER "ORSOVA"

First-class lounge on "B" deck forward, which has a simple decoration scheme and makes use of slat and spindle back chairs

A general view of the first-class dining-room looking aft, showing the panelled screens and the slatted ceiling

The veranda bar aft on "B" deck, showing the informal arrangement of furniture and the large photo mural of Sydney, about 1848

The starboard first-class gallery with its curved wagon-roof ceiling has green decorations to match the colour associated with that side of the ship

A view looking aft in the tourist library on "E" deck, showing the leather-covered seating arranged in bays along the deckhouse side

bar which is laid out around the engine-room uptake and has glazed screens opening out on to a sheltered veranda deck. There are raised alcoves to port and starboard, separated by railings from the rest of the room which has walls partly panelled in elm and partly painted, while the principal decoration is a large photo mural enlarged from an old print representing Sydney about 1848.

On the deck below is the swimming pool and adjoining it is the tavern, which has a tiled floor and walls in plastic sheet decorated with tavern subjects and objects. The furniture is of teak and the cushions are covered with waterproof patterned "Tygan." Over 300 passengers can be seated in the dining room, which is on "F" deck, and by the skilful use of panelled screens the open feeling of a large space has been masked to give the effect of a room within a room. Dark, mansonia and rosewood have been used for the panelling and for chairs in the centre space to contrast with the chairs and slatted panelling of the spaces at the sides which are in pink beechwood. The upholstery is of green leather and the room has brilliant-cut mirrors in shaped wood frames set in the dark panelling and a large mural depicting scenes representative of London. The slatted ceiling and panelling conceal acoustic material which is fitted to absorb the noise which inevitably arises. To starboard, curtaining and glazed doors are arranged to form a small separate dining room seating twenty-four, while a corresponding space to port serves as a children's room and is panelled in beech. The dining room is air conditioned and the other public rooms which are air conditioned are the library, restaurant and lounge.

A tee-form stairway rising from the dining room on "F" deck to "A" deck and flanked by two lifts is the main access to the accommodation and links the lobbies at the various levels, that at "C" deck being the shopping centre. On the half-landings of the main staircase are murals of the four winds. Another stairway serves the forward cabins and extends from "F" deck to "A" deck, while aft a stairway rises from "E" deck to a lobby on "C" deck whence wing staircases to port and starboard provide ready access to "A" and "B" decks.

Tourist Accommodation

Of the total of 813 tourist passengers, 278 are in two-berth cabins, 316 in four-berth cabins, and 204 in six-berth cabins arranged on three decks. The two-berth cabins are on "F" and "G" decks and the four-berth cabins on "G" deck, while the six-berth cabins are arranged on "H" deck. As in the first-class accommodation, plastic wall covering in pale colours is used in the cabins and alleyways and the cabins are comfortable and well fitted.

Considerable open space is available for games at the aft end of "C" deck, where there is also a swimming pool. On the deck below is the square which is fitted with folding screens and painted in bright contrasting colours. The space is available for dancing, race meetings and other entertainments including the showing of films. Aft of the square is the veranda bar, which is curved to resemble the stern of the ship and has ingle recesses with built-in furniture. Panelling is in wide oak boards relieved in places with a patterned plastic in donkey brown and the furniture is arranged to give a feeling of intimacy, while the chairs are based on the traditional Windsor pattern. The library is placed on "E" deck and is designed also for writing and to act as a card room. On the long walls leather covered seating is arranged in small bays and in a centre space, screened at one side by a carved oak grille, are the book-cases. Aft on the same deck is the children's play-room with its sand-pit, paddling pool and hinged weather screens.

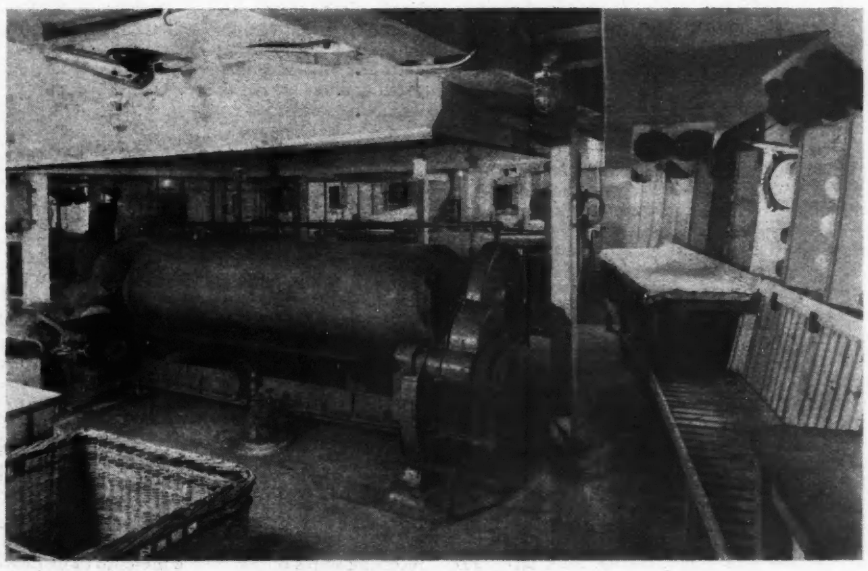
The lounge, which is on "F" deck, extends for the full width of the ship and is comfortably furnished with settees and easy chairs, while the centrepiece of the room is a large colourful decorative painting portraying a Cornish harbour scene. From the lounge, doors lead forward to the dining room, which is a large room, having a sound-absorbent ceiling and panelled in plastic, skilfully broken up by the use of glazed screens. Most of the tables are arranged to seat six or eight, but in the bays at each side of the room tables for four are arranged, in a style based on that associated with the old city chop-houses, with banquette seating. There is a small separate dining room to starboard for children.

Wing staircases lead down from the games deck to the veranda bar and square on "D" deck and to the library on "E" deck, and then continue as a centre stairway to give access to the cabins on "F" and "G" decks. Another stairway connects the cabins on "H" and "G" decks with the lounge, while a staircase further forward serves a similar purpose. Mr. Brian O'Rorke, assisted by Mr. John Wright, has been responsible for the interior decoration of the ship and has produced a scheme which, by the use of light and contrasting colours, has created in the ship a feeling of brightness and airiness.

The decoration of the public rooms, stairways and entrances has been carried out by Waring and Gillow, Ltd., Hampton and Sons, Ltd., Trollope and Sons (London), Ltd., Maple and Co., Ltd., and H. H. Martyn and Co., Ltd., while the various floor coverings have been supplied by Rowan and Boden, Ltd., Durastic, Ltd., and Semtex, Ltd. All the cabin lighting fittings are of General Electric Company's manufacture and Metropolitan-Vickers Electrical Company, Ltd., has supplied the fluorescent lamps and the emergency lighting in the public rooms. Bulls Metal and Marine, Ltd., has supplied the ship side and deckhouse windows, Henry Hope and Sons, Ltd., has supplied the windows for the lounge and the sidelights were manufactured by John Roby, Ltd. Holoplast, Ltd., supplied "Decorplast" veneers for panels and passageways. "Warerite" plastics have been used extensively for the tops of furniture and for panelling, and Esavian, Ltd., was responsible for the folding screens, while the heat and fireproof insulation for piping, ventilation trunks and air-conditioned spaces was carried out by Newall's Insulation Company, Ltd.

Crew Accommodation

Comfortable accommodation is available for the ship's staff, single cabins being provided for the officers, while the crew are housed in single, double, four, six, eight and ten-berth cabins. On the second bridge deck are the suites for the captain and staff commander, while the cabins for the navigating officers are arranged on the first and second bridges. The cabins for the engineer officers are on the starboard side of



The laundry at the aft end of "F" deck. In the foreground is the calender machine and the illustration indicates the size of the compartment

"E" deck and include a suite for the chief engineer. There is a separate mess and sitting room, which are air conditioned, as are also all the inside cabins. There are a number of air-conditioned cabins for the leading hands on "G" deck and also an air-conditioned mess and sitting room, while on the same deck is the crew's mess, also air conditioned. The petty officers' cabins are on "E" deck forward and there is a recreation space for the crew on "D" deck under the forecastle. The aft bulkhead of the space consists mainly of hinged screens, which can be opened up in the hot weather so that it is open to the crew deck. As for the passenger accommodation, plastic material has been used for cabin and alleyway bulkheads.

Hotel Services

The service rooms and galley are centrally placed between the first-class and tourist dining rooms on "F" deck. All the cooking is done electrically in the one galley, which occupies the space between the engine and boiler-room casings, and is equipped with island oven ranges, the electrical load being about 900kW. The various food preparing rooms, dairy, bakery and confectionery and the butcher's shop are arranged along the ship's sides and around the boiler casing, and the equipment has been mainly the responsibility of Henry Wilson and Co., Ltd. A large and well-equipped laundry is located right aft on "F" deck and is able to deal with the ship's linen and the passengers' requirements up to about 5000 pieces a day. J. J. Lane and Co., Ltd., has supplied the laundry equipment, which includes washers, hydro-extractors, power-operated presses and a calender. Ironing rooms are provided within the accommodation to give additional personal facilities for the passengers.

On the port side of "E" deck slightly aft of 'midships is the air-conditioned hospital, which consists of three wards, a nursing ward, a surgery and a consulting room, while aft on the same deck is the self-contained isolation hospital.

The ship is well served with lifts, there being a total of seven major units, all supplied by J. and E. Hall, Ltd. In addition to the two passenger lifts, already mentioned, there is an engineers' lift, which links their accommodation on "E" deck with the engine-room. Two lifts connect the stores on "H" deck with the galley; another is for expediting the handling of baggage down to the flat on "J" deck, and there is a lift for pantry service. The complete ventilation and heating system for the passengers' cabins, public rooms, officers' cabins and the crew's quarters has been supplied by Thermotank, Ltd., and is arranged to maintain a temperature of about 65 deg. Fah. under automatic control. In addition to the Thermotank heating system, convector pattern electric radiators, manufactured by E. K. Cole, Ltd., are fitted in the first-class and officers' cabins and the hospitals. Extensive air conditioning is provided in the ship for the comfort of the passengers and crew, and the spaces supplied include inside first-class cabins, library, restaurant, lounge, first-class and tourist dining rooms, certain officers' and crew's cabins, and messes, and the hospital block. The installations are capable of maintaining definite conditions of temperature and humidity in the spaces controlled through the medium of chilled brine, circulated through the air coolers, from a Foster-Wheeler steam jet refrigerator plant and a J. and E. Hall refrigeration plant.

Deck and Auxiliary Machinery

For working the cargo the derrick complement includes 5-ton derricks and a number of 10-ton derricks. They are operated by four 5-ton and sixteen 3-ton electric winches, and seven 1-ton topping winches, supplied by Clarke Chapman and Co., Ltd. This company also provided the warping capstans and the windlass with two capstan heads for handling the two 8-ton anchors. Brown Brothers and Co., Ltd., supplied the electro-hydraulic steering gear and also manufactured the Denny-Brown stabiliser gear, which is fitted in a compartment, immediately forward of the generator room, on the tank top. The fins each have an area of 84·5 square feet with the main fins having a working angle of 20 deg. and the tail flaps 30 deg. to the main fins. The equipment is designed to produce a righting force of 700 tons at 23 knots.

For raising the lifeboats there is a total of eighteen Welin Maclachlan boat winches and the other winches provided include those for handling the main accommodation ladders, which are of telescopic design and constructed of aluminium alloy. In association with the telescopic ladders are aluminium alloy landing stages which are carried in the ship and which are designed to expedite the embarking and disembarking of passengers.

In the refrigerating machinery space are four J. and E. Hall "Freon 12" compressors, each driven by a 180 b.h.p. Allen motor. Two of the machines are used for air-conditioning purposes and two for service with the refrigerated cargo holds and ship's store rooms. Two machines are interconnected so that either of the cooling services can be augmented as required. There is also a small Freon unit for deep freeze purposes in the compartment.

To deal with the sewage, the ship is provided with four sewage plants, supplied by J. Stone and Co. (Charlton), Ltd.; two are fitted in the tunnel space, a third unit is located to starboard in the boiler-room, and the fourth is mounted to starboard of the refrigerating machinery space.

Navigation and Safety Equipment

Maximum safety at sea has been a principal consideration of the owners and builders. There is adequate subdivision and cross-levelling pipes are arranged wherever there are longitudinal watertight and oiltight bulkheads so as to assist in correcting any list caused by damage to a wing compartment. In conformity with the latest Ministry of Transport rules, fire screen bulkheads fitted with "Dreadnought" fireproof doors subdivide the accommodation into zones, and, in addition, further protection is afforded by installation of "Grinnell" sprinklers, while all internal staircases are built of steel. There is an automatic fire alarm system and the holds and 'tween decks have a Pyrene smoke-detecting system, while the boiler-room has a Pyrene mechanical foam installation.

Hugh McLean and Sons, Ltd., has supplied the steel lifeboats, which are carried under Welin Maclachlan gravity davits. The boat complement consists of six boats fitted with a motor and each accommodating 138 persons; eight boats equipped with "Fleming" gear, four to carry 145 persons each and four to take ninety-nine persons each; two motor lifeboats to carry 114 persons each; two emergency boats, each accommodating forty persons, and one boat, with Fleming gear, to carry forty-eight persons.

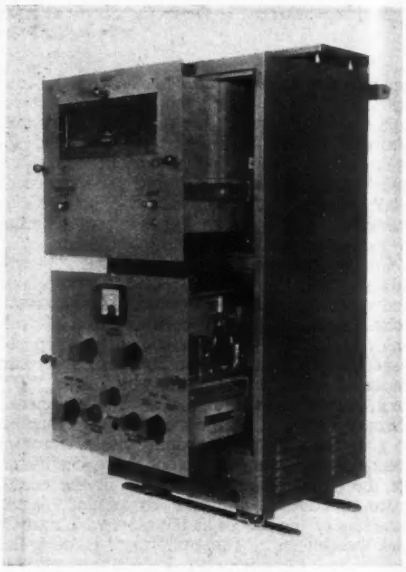
In the chart room and wheelhouse are to be found all the instruments required for the safe navigation of the ship, including Sperry gyro compass and automatic steering equipment, Kent clear view screens, rudder indicator, Chernikeeff log, Marconi echometer, compasses by Kelvin and Hughes (Marine), Ltd., Decca and Marconi radar equipment, and Marconi radio equipment, which will enable the ship to maintain world-wide communications.

Automatic Alarm Radio Receiver for Marine Use

A new form of automatic alarm receiver, designed to comply with the revised Post Office specification for the reception of the international radio alarm signal, has been developed and is being produced by the Marconi International Marine Communication Company, Ltd. This equipment is known as the "Seaguard." It is switched on when the radio officer goes off watch. It then maintains a reception watch on the distress frequency; if the international alarm signal of twelve four-second dashes at one-second intervals is transmitted by a ship in distress within range, the "Seaguard" responds before the end of the fourth dash by actuating an alarm bell system which calls the attention of the receiving ship's officers to the presence of distress signals. The radio officer, alerted by the alarm bell in his cabin, then returns to the wireless room and listens for details of the distress on headphones plugged into the receiver unit of the "Seaguard."

The "Seaguard" consists of two main units, the receiver and selector, both housed in one cabinet. The receiver is of optimum sensitivity, designed to ensure reception of alarm signals within a reasonable range without responding to transmissions from ships at too great a distance. It is pre-tuned on a frequency band of 490 to 510 kc/s, which gives adequate coverage on the distress frequency of 500 kc/s while still allowing for the reception of alarm signals from a transmitter which may be slightly off tune in an emergency. Because of its comparatively high sensitivity it has been designed with an elaborate automatic dual gain control system to provide circuit precautions against response to heavy traffic in congested radio conditions or to prolonged static, either of which, but for these precautions, might cause the "Seaguard" to operate the bells in a false alarm.

The selector is a discriminating electro-mechanical timing system built to stringent physical tolerances, to ensure that no succession of signals closely approximating the alarm signal is permitted to actuate the bell system. A highly stable electronic oscillator provides the audio-frequency power for the phonic motor which is



Marine "Seaguard" automatic alarm equipment, showing radio receiver and selector units withdrawn for inspection

the driving unit of the selector, and a system of cams, pawls and relays locks in progression on the receipt of each correctly timed and spaced dash.

An incoming signal passed from the receiver to the selector energises the input relay, which in turn closes a clutch bringing the cam and pawl system into operation. If the signal is correct the first dash pawl engages at the end of 3·45 seconds, and at the end of 4 seconds the space cam begins to rotate. After a lapse of 1·55 seconds this cam closes a pair of contacts which, unless the next acceptable dash has begun, will operate a trip relay returning the mechanism to its datum position. Thus the required one-second interval between dashes, within reasonable limits of accuracy, will not operate the trip. The second dash, starting before the end of 1·55 seconds, therefore actuates its pawl which engages and holds if this dash is also correctly timed. The mechanism continues to operate in a similar way through the reception of the third dash until, when the fourth dash has lasted 3·45 seconds, the alarm relay is closed, completing the bell circuit and alerting the ship's officers.

Rejection of false signals caused by two or more stations transmitting simultaneously on the same level of volume and therefore producing between them long dashes is guarded against by extremely accurate timing. The "Seaguard" is designed to register very short gaps in trans-

mission down to less than 10 milliseconds and can therefore "see through" prolonged but slightly broken interference which would otherwise simulate, and be accepted as, one continuous dash. The dash mechanism rejects any signal lasting less than 3·45 seconds or more than 6·1 seconds, while the space cam, as stated earlier, trips the mechanism if any space is longer than 1·55 seconds.

Although chance transmissions may combine to produce an acceptable first dash, engaging the first dash pawl, it is unlikely that the following interval will be correct; but if that should happen, and a second false dash starts before 1·55 seconds have elapsed, the likelihood of further false dashes and intervals being correct becomes progressively more remote. As the selector is on the alert to trip and return to datum no false alarm will be given unless the interference pattern throughout a period of 20 seconds is almost identical with the alarm signal. Such patterns of interference do, of course, sometimes occur, and false alarms are sounded, but it is considered that this is much more desirable than that a genuine distress call should be missed through the imposition of too narrow limits of acceptance.

The "Seaguard" has its own built-in power unit and can be supplied for operation direct from ship's 110V d.c. mains, using a small voltage dropping unit for 220V d.c. operation, or if to be run from a.c. mains, with an external transformer and rectifier unit. In compliance with regulations the supply for the alarm bell circuit is drawn from the ship's 24V emergency battery. Any breakdown in either receiver or selector causes the bells to ring, and the lighting of one of two indicator lamps on the front panel shows which unit is at fault. A third lamp gives visual warning of the reception of the alarm signal, and a built-in meter provides facilities for checking the various feed currents to the valves of the receiver.

Vertical Continuous Milling

A PHOTOGRAPH we reproduce on this page shows one of the vertical continuous milling machines made by Adcock and Shipley, Ltd., of Ash Street, Leicester, which the company recently fitted up specially for the straddle milling of aluminium components. In it the usual rotary table is replaced by a special table incorporating hydraulically operated fixtures.

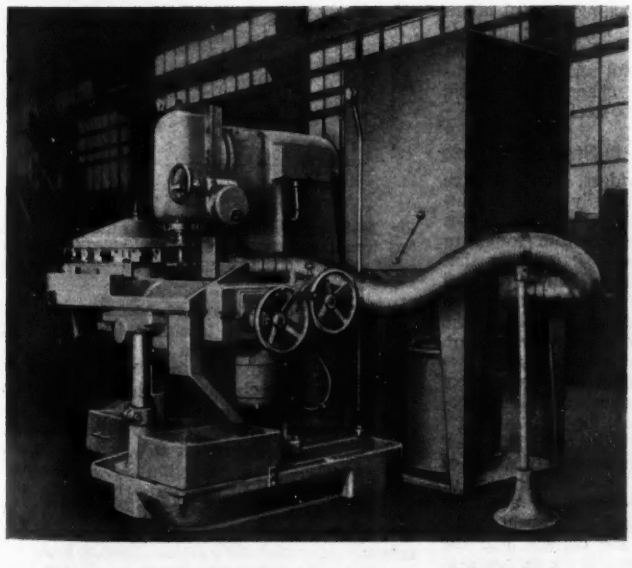
This design of machine has a sliding head with a vertical adjustment of 3½in, and in it the spindle is usually driven through a built-in variable speed pole-change motor and gearing, giving a range of speeds from 40 to 1100 r.p.m. The special machine has a single speed, 5 h.p. motor and the drive is transmitted through a reduction gear box to give a constant spindle speed of 658 r.p.m., or the equivalent cutting speed of 1000ft per minute to the 6in diameter cutters used.

The rotary table and work-holding fixture are arranged as one unit, and means of longitudinal adjustment only is provided for the withdrawal of the cutter from the work. The sliding head with its movement of 3½in, provides sufficient vertical adjustment for setting the cutters relative to the work.

The special table has two knee steadies and the hydraulically operated work clamps are supplied with pressure fluid from a separate motor-driven pump at the side of the machine.

The oil supply is fed under pressure to the centre of the fixture and passed through radial valves to the radially disposed cylinders operating the clamping mechanism of the fixtures. One cylinder is used for each pair of fixtures. As the table rotates, pressure is applied, first to one end of the cylinder to clamp the component, and after machining oil is fed to the other side of the cylinder to release the component. In the loading and unloading position the component is lightly held by springs to retain it until the full clamping pressure is applied hydraulically.

The question of swarf was given most careful consideration and the fixture has a conically-shaped top of sufficient steepness to prevent swarf lying on it. Rubber mouldings are used around the moving parts of the fixtures to avoid any small particles of swarf entering them A Dallow Lambert "Dustmaster" acts as a swarf extractor to collect the majority of the swarf into a suitable container at the rear of the machine.



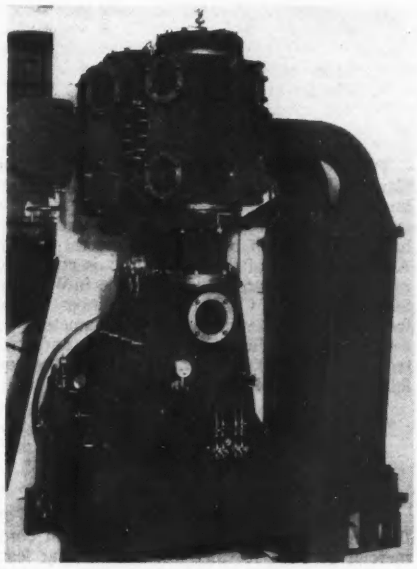
Vertical continuous milling machine with special rotary table equipped with hydraulically operated work clamps

Improved Range of Air Compressors

DURING a recent visit to the Birmingham works of Belliss and Morcom, Ltd., we were shown one of a range of compressors of considerably improved design which has now been placed in production. The particular model illustrated is one of 2000 cubic feet per minute capacity, compressing to 100 lb per square inch at 375 r.p.m. These machines are of the double-acting, two-stage, crosshead design, with capacities ranging from 500 to 10,000 cubic feet per minute at 80 lb to 120 lb per square inch. A range of single-stage units incorporating the same modifications is also available.

The essential modifications of these compressors lie in the design of the cylinders, valves and intercooler, the lower parts being generally similar to previous practice. Apart from the higher efficiencies obtained, each model is lighter and smaller than its existing counterpart and all are more easily maintained.

The modified iron cylinder is cast in one piece with the valve pockets in the cylinder barrel, thus simplifying the cylinder covers, eliminating air passages into the covers, and avoiding the possibility of water leaks. As the inlet and discharge valves are on opposite sides of the cylinders the corresponding passages are entirely separate, and any preheating of the cool incoming air is eliminated. The air passages, which are entirely formed in the cylinder, have been carefully designed to give a streamlined flow, and this, in conjunction with the one-way movement of the air through the cylinder, results in minimum pressure loss. The arrangement of valves in the cylinder barrel enables the whole of the surfaces exposed to air compression to be effectively cooled, and adequate cooling can be arranged, also, all round the valve pockets.



Newly designed air compressor showing valve arrangement and cooler design

A simple piston of box design, which is fabricated in two halves and welded together, is fitted with "Rowan" rings for long life. Metallic packings are fitted in the lower cylinder cover to provide an effective seal around the piston rod.

The redesigned spring cushion valve is claimed to represent a considerable advance on other existing plate valves. It is effectively frictionless, can operate successfully with relatively high lifts, and has a very large effective through area for a given valve area.

It is simple in design, has few parts, and is arranged for easy assembly and cleaning. It consequently obviates the wear experienced in guided valves, and ensures quick opening and closing with sustained tightness. The complete valve assembly is fixed in the cylinder by clamping the periphery of the valve seat; in this way possible seat distortion is avoided.

The modified multi-stage intercooler is arranged with a single air pass and six or more water passes, the contraflow arrangement ensuring a minimum air pressure drop. The trunking, which can be seen in the illustration, ensures that the air is evenly distributed down the cooler and is a contributory factor to the high efficiency claimed for it. The tube stacks are easily removable from the body for cleaning. These improvements have resulted in brake horsepower inputs down to 18·5 b.h.p. per 100 cubic feet of free air per minute compressed to 100 lb per square inch discharge pressure at sea level.

The bed-plate and casing are robust castings with adequate inspection doors. The bed-plate forms also the oil sump, and is flat bottomed for easy erection. The guide in the casing for the crosshead slippers is a separate casting to facilitate manufacture and servicing. The main bearings are of tin-based white metal bonded to steel shells, and are designed not only for radial loads, but also for any thrust load that may be present, depending upon the kind of drive.

The marine pattern crankpin bearing is of steel lined with tin-base white metal, and is adjustable. The crosshead bearings are also lined with tin-base white metal and are adjustable. All the bearings throughout the compressor are fully forced lubricated, including the crosshead slippers.

TOOL HONING MACHINE.—A small honing machine for bench mounting has been developed by Woodhouse and Mitchell, Brighouse, Yorks, to replace flat oilstones for sharpening scrapers, chisels, &c. This machine has twin circular oilstones 7in diameter by 1½in wide, driven at 100 r.p.m. by a centrally disposed fractional horse power motor through reduction worm gearing. Pivoted work support tables can quickly and easily be set to facilitate honing of the tools to the required cutting angles.

Metallurgical Topics

Quenching Cracks

THE Metals Research Laboratory of the Carnegie Institute of Technology, Pittsburgh, has undertaken a study of the incidence of quenching cracks in hollow cylindrical forgings, and results have already been published in several papers. A brief account of the conclusions is contained in a recent article on "Quench Cracks in Wrought Steel Tubes," by C. Wells.* The tubes ranged from 4·5in to 18·0in in outside diameter and from 1·2in to 7·5in in inside diameter, and were from 80in to 300in long. Their composition fell within the following limits :—

	Per cent
Carbon	0·25 to 0·5
Manganese	0·6 to 0·8
Chromium	0·6 to 2·2
Nickel	0·7 to 2·4
Molybdenum	0·25 to 0·5
Vanadium	Nil to 0·1

A preliminary study of the data obtained on thousands of quench cracks occurring in commercial practice revealed the fact that at least 2 per cent of all water-quenched tubes contained cracks. Radial cracks starting from the bore were most common. There were large differences in susceptibility to cracking among forgings from steels having essentially the same composition, made and treated in the same way, and the tendency to crack varied among tubes from a single heat. The problem thus became statistical in nature. Observation of the behaviour of commercial forgings was supplemented by a test of susceptibility to cracking developed at the Carnegie Institute of Technology.† Standard test discs, 6½in external and 2¾in internal diameter and ½in thick, were notched on the bore before treatment. The minimum depth of notch required to cause cracking was taken as an index inversely proportional to cracking susceptibility. The deeper the notch required to cause cracking the less the tendency to crack.

It was found that the major cause of quenching cracks, and very often the major remedy for them also, varied with differences in practice, but conditions affecting their formation were considered in detail and may be briefly summarised as follows :—

Ingot Size and Cross Section of Forging.—Susceptibility to cracking increased with increasing wall thickness of the forging, but ingot size and amount of reduction on forging were of questionable significance. It was suspected that resistance to cracking decreased with increased size of ingot and with decreased forging reduction.

Ingot Structure.—A poor primary structure and the presence of an excessive number of non-metallic inclusions were believed to be a major cause of cracks in quenched forgings, though many cracked forgings were practically free from non-metallic inclusions. Cracks frequently occurred in material from the region of the cone of solidification formed by the intersection of the dendrites growing from the bottom and from the sides of the ingot.

Bore Defects and Surface Decarburisation.—Inclusions, hair-line cracks and forging defects at the bore were always found to be highly detrimental, but opinion about the harmfulness of decarburisation was divided. Rough machining before treatment was desirable.

Composition of the Steel.—A high carbon content increased susceptibility to quenching cracks. No tubes with 0·26 per cent of carbon or less cracked when quenched to martensite ; and no tubes with 0·35 per cent or less cracked when quenched to a mixture of martensite and bainite. The detrimental effect of carbon was considered to be primarily due to its influence on the temperature of formation of martensite. Carbon lowers M_f more than M_s and so increases the M_s–M_f range in which martensite is formed. It seems that a given addition of carbon should increase susceptibility to cracking more than would a comparable addition of manganese, and manganese more than an equivalent addition of other alloy elements. Normal variations of composition in a given grade of steel appeared to be relatively unimportant.

Hardenability.—In so far as increased hardenability is accompanied by a lowering of M_s, there is a tendency to conclude that increased hardenability increases susceptibility to cracking. Actually data from several sources have confirmed the view that, if M_s is not changed, hardenability may be varied considerably without affecting the cracking susceptibility of steels quenched to martensite.

Uniformity of Quench.—Tubes 7½in outside and 2½in inside diameter and 110in long were hung vertically and arranged so that, on quenching, certain tubes had two neighbours, one on each side ; others had a neighbour on one side and others no neighbours. Tubes with no neighbours were found to be most uniformly quenched and cracked least frequently. Tubes that had one neighbour only were least uniformly quenched and cracked most frequently.

Other Conditions of Heat-Treatment.—Increasing the austenitising temperature tended to increase susceptibility to cracking. A plot of the percentage of forgings cracked against the finishing temperature of the quench within the range 100 deg. to 500 deg. Fah. (38 deg. to 260 deg. Cent.) showed that the probability of the occurrence of quench cracks decreased with increasing finishing temperature. This conclusion was confirmed by laboratory experiments. Quenched tubes, while still warm, should be transferred to the tempering furnace if cracking between quenching and tempering is to be avoided. It was also confirmed that normalising before austenitising tended to decrease susceptibility to quench cracking.

Many of the precautions which it is desirable to take against the occurrence of quenching cracks are self evident from the information given above. Provided that a suitable composition is being used, it is more logical to give full effect to such precautions before making any change. If, however, an improved composition is being sought, it should have carbon on the low side, a higher M_s as well as M_f and a smaller transformation range, a balanced alloy composition to ensure more than the minimum necessary hardenability and resistance to tempering, and mechanical properties needed to meet specification requirements and to perform satisfactorily in service. Two other methods of reducing the incidence of quenching cracks are recommended in the paper. One is the adoption of pre-bore quenching. This consists of quenching the bore initially for a certain time, followed by a simultaneous quench of the bore and the outside surfaces. A pre-bore quenching time of about 10 per cent of the total quenching time is tentatively recommended. The other method recommended as a successful remedy in appropriate circumstances is a change from basic open-hearth to basic electric steel.

Manganese-Carbon Ratio in Structural Steels

STRUCTURES such as bridges, ships, storage tanks and pipelines are usually made of hot-rolled, semi-killed mild steel. For such purposes a low transition temperature from tough to brittle fracture is desirable, as it indicates that the steel is less likely to fail suddenly if exposed to low temperatures in service. Heat-treatment or complete deoxidation, designed to lower the transition temperature, would seriously interfere with production, and everything possible is therefore done to improve the steel in this respect by control of composition and of rolling procedure. In this connection the work of Barr and Honeyman in 1947 will be recalled. They established the fact that in normalised steels of this type containing 0·10 to 0·23 per cent of carbon increasing the carbon content raised the transition range and lowered the impact value, while increase in manganese content had the opposite effect. Thus, increasing the manganese/carbon ratio lowers the transition range of the steel in the normalised condition. They also showed that increasing the manganese/carbon ratio tended to give a finer grain steel as determined by the McQuaid-Ehn test.

A paper by F. W. Boulger and R. H. Frazier* has recently appeared describing work carried out at the Battelle Memorial Institute on the "Influence of Carbon and Manganese on the Properties of Semi-Killed Hot-Rolled Steels." Though tensile properties are also dealt with, the main part of the paper refers to an investigation of the influence of these elements on transition temperatures. They used induction furnace melted, semi-killed steels containing 0·14 to 0·34 per cent carbon and 0·21 to 1·46 per cent manganese, hot rolled into ¾in plate at a finishing

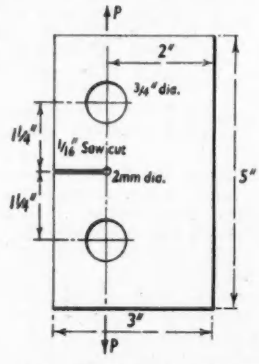


Fig. 1—U.S. Navy tear test

temperature of 1000 deg. Cent. There were five different carbon levels, each with a range of manganese contents. Their tensile properties are recorded but the main effort was directed to investigation of their transition ranges. As is well known, the transition temperature is dependent on the method of testing adopted and on the criterion used to define it. In this work use was made of the Navy tear test, in which the test pieces (Fig. 1) of full plate thickness are broken at various temperatures in a tensile testing machine. Each test includes the taking of an autographic load-extension diagram from which the work done up to maximum load and that required to complete the fracture can be separately calculated. The latter portion of the work done shows a sudden drop over a fairly

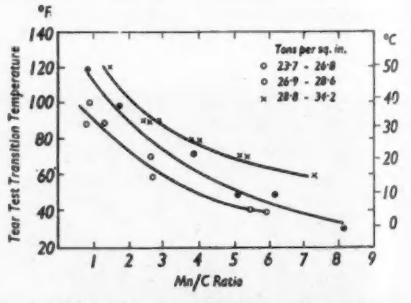


Fig. 2—Effect of manganese/carbon ratio on the tear test transition temperature of semi-killed mild steel (Boulger and Frazier)

narrow range of temperature, accompanied by a change in the type of fracture. The transition temperatures determined in this way are plotted in Fig. 2. The other test used was the Charpy impact test on specimens with the keyhole notch (2mm diameter, 5mm deep) broken at different temperatures. The transition temperatures, defined as the temperatures at which the impact value was 20ft-lb are plotted in Fig. 3. Another set of transition temperatures based on the 12ft-lb level is also given in the paper. In accordance with previous experience (to which reference is made), carbon was found to raise and manganese to lower the transition temperature

* *Metal Progress*, May, 1954, page 113

† *Trans. Am. Soc. Metals*, 1950, Vol. 42, page 206.

* *Journal of Metals*, May, 1954, page 645.

by whatever criterion this was determined. For equal tensile strength, steels with the higher manganese/carbon ratio had the better notched-bar properties. Increasing the manganese/carbon ratio also tended to refine the grain size of these steels, but the effect of grain size alone was not large enough to be important. While not denying that grain size might have an effect on notched-bar impact figure, the authors found no correlation between the notched-bar transition temperature and austenitic or ferritic grain size in the steels studied.

There was a certain regularity in the effect of carbon and manganese which could be reduced to linear equations, containing appropriate coefficients for carbon and manganese contents,

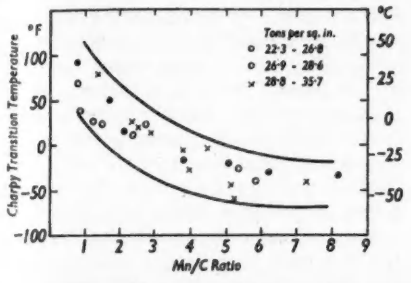


Fig. 3—Effect of manganese/carbon ratio on the 20ft-lb keyhole Charpy transition temperature of semi-killed mild steel (Boulger and Frazier)

from which the properties, including transition temperatures, of steels of this kind could be calculated. These formulæ are not reproduced here as a check on them showed that, although they represent the properties of the induction furnace steels studied with considerable accuracy, they are for practical purposes useless when applied to commercial steels with varying silicon and residual elements. These laboratory tests, however, provide a further confirmation of the now generally recognised importance of controlling the manganese/carbon ratio in structural steels and afford support to the recommendation made by Barr and Honeyman† that "for ship-building steels the manganese/carbon ratio should be not less than 3·0."

Surface Cracking of Railway Wheels

THE surface cracking or "thermal checking" of wrought steel railway wheel material is discussed by H. R. Wetenkamp* of the University of Illinois in a paper to the American Society of Mechanical Engineers. The wheel has not only to support the weight of the car but also to act as a brake drum. The tread of the wheel can thus be heated to temperatures well above the critical range of the steel. The high temperature of the surface is accompanied by a very steep temperature gradient. The result of the chilling effect of the underlying metal is the formation of a hardened skin and later of a network of cracks. These may be so fine as only to be detected by magnetic examination, but if they spread they may have serious consequences. The importance of preventing the formation and spread of such cracks has long been recognised.

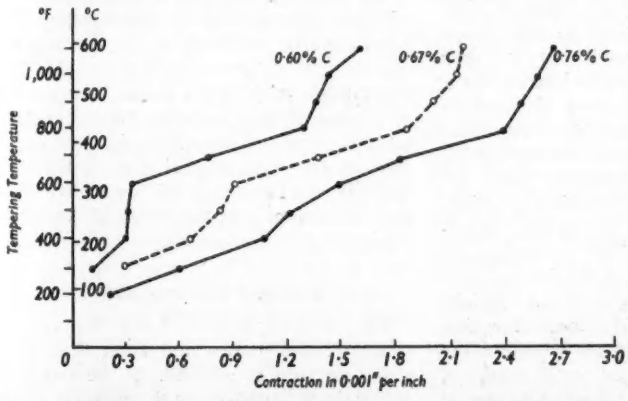


Fig. 1—Contraction on tempering quenched specimens of carbon steel (Wetenkamp)

The work described was undertaken to obtain a better idea of the circumstances under which thermal checking originates, and of the mechanism by which the cracks are formed. In investigations at the University of Illinois the wheel to be tested, along with a flywheel, equivalent to 20,000 lb travelling at the same speed as the tread of the wheel, was rotated at 1074 r.p.m. (115 m.p.h.) and then stopped by forcing two brake shoes against the tread of the wheel with a force of 20,000 lb on each shoe. By releasing the brakes when only a small percentage of the total energy had been absorbed, many small cracks were found to have formed, though magnetic inspection was required to see them. Preliminary observations indicated that at least two heat cycles were required to produce the type of check being studied. The first cycle produced a hardened zone, while the second cycle provided an overlapping hot-spot which apparently tempered a portion of the originally hardened zone. If such an overlapping of hot spots occurred the usual result was a thermal check. Tests were also carried out on small specimens (2½in by 2½in by ½in). Cold water was directed against the bottom of the specimen while the upper surface was heated by a moving oxy-acetylene torch. The duration of the heating was about thirteen seconds followed by an interval of fifty seconds (with the water still running) before a second heating was begun. Six steels were used with carbon contents of 0·83, 0·76, 0·67, 0·60, 0·54 and 0·45 per cent. Increasing carbon content within this range rendered the steels more susceptible to thermal checking. Some reasons for this may be that low carbon steels must be heated to a higher temperature to become completely austenitic, and must be quenched more drastically to produce a martensitic structure. In steels of higher carbon content the transformation from austenite to martensite is accompanied by a larger increase in volume, but the decrease in volume which takes place on tempering the martensite is also greater. This contraction on tempering martensite was measured in several of the steels. Specimens, 5in long and ½in diameter, were water quenched. A 3in length was cut out and the ends ground parallel. These accurately measured specimens were then tempered at intervals of 100 deg. Fah. in a salt bath for thirty seconds. A trend of increasing contraction with increased carbon content was noted (Fig. 1). Although the course of these curves may not be very accurate, they agree, in order of magnitude of the maximum contraction, with determinations of the specific volume of quenched and tempered steels. For example, the contraction in volume of quenched 0·71 per cent carbon steel when fully tempered is 0·9 per cent,† equivalent to a linear contraction of 0·3 per cent, which roughly corresponds to the maximum contraction shown in Fig. 1. Data of a qualitative character were obtained for residual stress. The heat affected zone, subjected to the initial heating cycle, was found to be under a compression stress of 40,000 lb to 80,000 lb per square inch. After a second cycle under conditions such that heat checking was impending, there was a tensile stress of 60,000 lb to 85,000 lb per square inch at the surface.

The explanation of thermal checking put forward by the author of the paper is as follows: At the temperature reached locally in the initial heating or hardening cycle (about 1100 deg. Cent.) coarse grains are formed and plastic deformation of the surface layer takes place to compensate for its thermal expansion. The quenching phase of the cycle produces a microstructure of coarse grained martensite. The austenite-martensite transformation causes an expansion which counteracts the tensile stress which would be produced if no transformation products were formed, and leaves the surface material in a state of compressive stress. The tempering cycle causes a contraction of the martensite which, in turn, gives rise to tensile stresses which may be sufficient to initiate cracks in the original austenite grain boundaries. In support of these views, it was found that the cracks were intergranular and the microstructure was that of tempered martensite. For a given type of steel, also, there was a hardness (not the maximum) which favoured cracking.

"Thermal checking" may occur in different circumstances on the surface of many kinds of material. It is often connected with volume changes associated with structural transformations, but in many cases the restraint of thermal expansion and contraction may be sufficient to cause surface cracking, which may occur in some non-ferrous metals when they undergo alternate heating and chilling. Moreover, the coefficient of thermal expansion of austenite is much greater than that of pearlitic steel. In some compositions of steel, contraction of the rigidly held surface layer of austenite is not fully compensated by its expansion on transformation to martensite. Differences in composition and in the nature of the thermal cycles undergone may involve modification of the theory if applied to other types of thermal checking.

Low Temperature Properties of Beryllium-Copper

THE low temperature properties of beryllium-copper alloys are of interest in connection with the increasing use of this class of alloy for springs and other components at sub-zero temperatures. The work of Colbeck and MacGillivray[1] and of C. S. Smith[2] indicated that, like most copper alloys, 2½ per cent beryllium-copper showed a pronounced improvement in yield stress and tensile strength, with no appreciable loss (and possibly a gain) in elongation and no drop in impact value, as the temperature was reduced. Between +20 and −180 deg. Cent. the solution-treated alloy showed an increase in tensile strength from 34 to 50 tons per square inch with an elongation of about 40 per cent and an Izod impact value of 40ft-lb, whilst the fully temper hardened specimen showed an increase from 83 to 96 tons per square inch in tensile strength with variable elongation between 0·4 and 3 per cent and an impact figure of 3ft-lb. As neither the composition nor the conditions of treatment were those now most commonly used for springs, mechanical tests at sub-zero temperatures have been made by J. T. Richards and R. M. Brick[3] on alloys of the following composition, cold drawn, half-hard in the solution-treated condition and then tempered. At low temperatures there was a drop in ductility and impact value of the unaged specimens, a condition not employed in practice. In the artificially aged specimens, there was an increase in yield strength, in tensile strength and in uniform elongation but there was a lower total elongation because of less necking, shown by a decrease in reduction of area. The beryllium-copper alloy had the following properties:—

Temperature, deg. Cent.	+26	−185
0·002 per cent proof stress, tons per square inch	45·5	47·0
0·2 per cent proof stress, tons per square inch	75·4	88·5
Tensile strength, tons per square inch	86·6	96·5

The elastic behaviour of the alloys was of interest in connection with their use as springs. Decrease in temperature is said to extend the elastic range though stress-strain relationships are not linear. In the stress-strain diagram, curvature occurred below the elastic limit owing to an elastic rather than plastic behaviour, but the curvature became less at low temperatures. The tangent modulus of elasticity was $18{\cdot}2\times10^6$lb per square inch at 26 deg. Cent. and $18{\cdot}85\times10^6$lb per square inch at −185 deg. Cent. The corresponding mean values of the modulus over the range 0 to 35 tons per square inch were $17{\cdot}9\times10^6$ and $18{\cdot}7\times10^6$ lb per square inch respectively. The other alloys showed similar behaviour.

† *Journal of the Iron and Steel Institute*, October, 1947, Vol. 157, pages 239 and 243.
* *Trans. A.S.M.E.*, May, 1954, page 469.
† Andrew and Honeyman: *Carnegie Scholarship Memoirs*, 1924, page 253.

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THE "MECHANICALS" IN HOLLAND

There is a peculiar stimulation about going abroad. The things that members of the Institution of Mechanical Engineers did during last week's Summer Meeting in Holland were much the same things that they would have done had the meeting been held in some British city. An official welcome was offered by Mr. F. M. A. Schokking, Burgomaster of The Hague and by Dr. J. A. Ringers, President of the Koninklijk Instituut van Ingenieurs, to which Dr. R. W. Bailey, President of the Institution, replied; a paper was read about industry in the area; there was a reception at the town hall; and there was an Institution dinner. In short, the programme conformed to a familiar pattern. Yet it gained a new vitality and proved more stimulating because, in detail, there were constant big and little surprises that did not conform to pattern. Some of those surprises seemed a little whimsical to the British guests, like the serving of wafer-thin slices of meat and cheese for breakfast; some were deeply touching, like the abiding richness of Dutch gratitude for the country's liberation by British troops, of which there is tangible evidence at the Arnhem cemetery; some entertaining, like the opportunity given to members who visited K. M. G. Stork and Co., Ltd., to see, over lunch, an exhibition of Dutch folk-dancing in clogs; some delightful, like the facility of so many Netherlanders in the English language and the charm of their accent for English ears. Then again a reception held at a town hall like that of The Hague, rich in historical association with a land other than Britain, is different in character from the same function held at home; and journeys by rail are more interesting in an unfamiliar land, particularly one that presents scenery so different from that of most parts of Britain. Almost a sufficient number of windmills was observed to satiate the appetite of a particular member! And in a country whose economy, though very similar to that of Britain, yet differs in some degree from it, there is always something of unusual technical interest to see or hear about in the course of works visits. The foundations for a successful meeting were therefore ready-made in Holland before the members left England. All that was needed was hospitality from hosts—which was abundantly given—and organisation which, in the event, fell little short of perfection.

Success was assured almost from the very start by the friendliness of the welcome offered at the opening meeting and by the presentation by Ir. F. Q. den Hollander, President of the Netherlands Railways, of a masterly survey of Dutch industries which related industrial achievements to the natural features of Holland and its economic needs and gave members a broad picture of the state of the country they had come to visit. As Mr. A. C. Hartley remarked in a speech at the dinner, proposing the toast of "The Engineering Profession and Industries of the Netherlands," both Britain and Holland are maritime nations, both are labouring under similar economic problems, both are seeking higher productivity in industry, both are concentrating on the production of high-quality goods, and both, though the Netherlands more especially, have to guide the forces of nature for the protection of their coasts. How well the programme of visits arranged by the Institution in collaboration with the Instituut illustrated those points! High productivity was seen at the works of Philips and Van Doorn's at Eindhoven; high quality and varied production at Stork's in Hengelo, and Werkspoor's at Amsterdam; the struggle for economic operation could be inferred from the conversion of railways from steam to electric and diesel-electric operation; the means for research and technical advance could be examined at Delft; shipbuilding ability was seen at the particularly fine Wilton-Fijenoord yards, and, upon the final day, the capacity of Dutch civil engineers was illustrated by a visit to a polder in the former Zuider Zee, now called, since the great dyke across its mouth converted it into a fresh water lake, the Ijsselmeer. There, indeed, as they sailed upon the Meer, out of sight of land, to see the works in progress, members conceived an esteem approaching awe for the courage and skill of Dutch engineers, wresting land from the sea. Nor anywhere else, probably, could there have been found a better place to exhibit their achievements than at the one-time Zuider Zee island of Urk, whence the new fertile fields of the N.E. polder, reclaimed during the war, can be seen extending to the horizon at a level visibly 12ft or more below the waters of the Meer. That visit, indeed, blessed as it was by fine, warm weather, made a fitting conclusion to a meeting that gave to all who attended it a renewed respect for Dutch engineers and a growing liking for the people of the Netherlands.

Members came back to this country from Holland, with, we believe, a very lively hope that the organisation of another meeting on the Continent will not be too long delayed. We share that hope. For to gain a true picture of British engineering achievement it is essential to see how engineers in other lands set about tackling engineering problems. But, equally, to assess the merits of foreign engineering achievements, a visitor must be aware of what is going on at home. There must, then, be Summer Meetings at home as well as abroad; and it does not seem possible for the Institution to lay down any hard and fast policy fixing intervals between foreign visits. For it is a tradition of the Institution, that Presidents whose work has been closely identified with certain regions of this country shall take the members for their Summer Meeting to that region. It is a good tradition. When, however, a President has no such special ties, we hope, and we believe all those who went to Holland will also hope, that consideration will invariably and automatically be given to a meeting abroad. For there was no doubt about the success of the meeting. Indeed, we heard only one criticism. It was that members might well have travelled to Holland on the Sunday instead of the Monday so that thereby the programme might have been arranged to permit members a half-day free of engagements in which to do a little sight-seeing on their own. That is a kind of criticism—like Oliver Twist asking for more—that the Institution can feel flattered to have received!

H.M.S. "ARK ROYAL"

The aircraft carrier "Ark Royal," a vessel of 36,800 tons and 803ft in length, which has now commenced her contractor's sea trials, is expected to be ready for commissioning next year—some twelve years after she was laid down in May, 1943. Two other ships of this class were ordered, but one was cancelled at the end of the war. The third, H.M.S. "Eagle," is now in service. The large carrier proved its value for offensive operations in the Pacific, but British shipyards were working to capacity in 1942-43 as the result of the "U"-boat campaign, and it was not practicable to build any more

carriers of this size at that time. Our most effective carrier contribution, for use both in the Atlantic and Pacific, seemed to lie in a smaller general purpose carrier which could be built more quickly and with fewer resources. Several of these vessels—called light fleet carriers—were completed before or soon after the end of the war but some, including the four " Albion " class—a larger and much faster type laid down in 1944—had little work done on them before the rearmament programme and are only now completing or about to enter service.

With the introduction of high-speed, heavy jet aircraft, it looked after the war as if we were to be committed to building carriers of the " Ark Royal " type to provide the length of deck required for flying on. Moreover, the conventional hydraulic catapult appeared unlikely to be able to launch the jets coming into service in the immediate future. Meanwhile the cost of construction of the large carrier has quadrupled since the war. The " Eagle " cost £16,000,000, compared with £4,000,000 for a 1939 carrier, and the figure for the " Ark Royal " will certainly be very much higher. It was thus inevitable that many people—with no experience of naval operations—argued that carriers are uneconomical, vulnerable and unnecessary and that the protection of sea communications could safely be left to long-range shore-based aircraft. Fortunately, British inventive genius has saved us from this dangerous alternative. In the past two or three years, Britain has produced the angled deck, the steam catapult, improved arrester gear and other improvements which make it possible to operate all the types of aircraft required by the Royal Navy from fast medium-size carriers, vessels which can be built at a reasonable cost. It is also worth noting that the steam catapult may eliminate one of the risks of fire in carriers. Several witnesses in the inquiry into the recent disastrous fire in the U.S. " Bennington " testified to having seen quantities of dense, yellowish smoke which smelt strongly of the highly inflammable hydraulic oil used in the conventional catapult.

The fast medium-size carriers now completing are indeed in no way inferior to the " Ark Royal " in any operational role. They can, it is true, operate less than half the number of her aircraft, but it is preferable for this country to have a greater number of carriers each operating relatively few aircraft than to put all the eggs into a very few large baskets. There are many focal areas of trade to defend where air attack may be expected on a minor scale. Equally, when carriers form part of a task force, giving tactical support in amphibious operations pending the construction of airfields ashore for the R.A.F., losses from submarine and air attack and from mines are bound to be heavy. It thus seems probable that the " Ark Royal " will be the last large carrier to be built for the Royal Navy. On the other hand, the tendency in the United States Navy is to build still larger carriers. Before the war was over, the United States laid down three " Midway " class carriers of 45,000 tons and these ships are now being reconstructed and modernised at a cost of about 50,000,000 dollars per ship. Fourteen of the twenty-four " Essex " class carriers of 27,000 tons have also been reconstructed, the modifications including larger lifts, strengthened decks and greatly increased petrol stowage. The tonnage of these fourteen vessels has, in fact, been increased to 38,000 tons—somewhat larger than the " Ark Royal." Recently two more carriers of 60,000 tons have been laid down and a third has been authorised. The explanation lies in the role planned for U.S. carriers—to launch medium-range aircraft to bomb targets a thousand miles inland and to develop carrier-based airlifts and thus make possible the landing of ground troops far into enemy territory. U.S. naval personnel are, in fact, being trained to regard their navy as a force capable of operating against a land power by means of fully equipped air bases at sea, with anti-submarine defence as a secondary mission necessary for the protection of those bases to enable the Navy to perform its offensive operations against shore targets.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

SIR CHARLES PARSONS

SIR,—On reading over the article on the centenary of the birth of Sir Charles Parsons, in your issue of June 11th, I was surprised to note your statement that Sir Charles Parsons " made experiments with the reheating of the steam between the cylinders of his first tandem compound turbine in 1900," and that in 1916 he made a really important advance by constructing a compound turbine, including both feed heating and reheating, inaugurating the heat cycle characteristic of the most efficient power plants of to-day.

Surely this statement is incorrect. All the evidence available seems to indicate that Parsons was responsible for practically every important improvement in steam power engineering during his lifetime except feed heating and reheating. The first power station in the world incorporating these improvements was the North Tees power station, in which the firm of Parsons had no hand whatsoever, the main boiler plant with steam reheaters being supplied by Babcock and Wilcox, Ltd., and the turbo-alternators and condensing plant being constructed by Metropolitan-Vickers Electrical Company, Ltd. Both the feed heating and the reheating were constructed to the patents of Dr. S. Z. de Ferranti, these being taken out by Ferranti in Britain and America (and probably in other countries as well) about the years 1906-1908. The American patents were valid to a later date than the British, and, in fact, Ferranti visited the United States in 1924 to attempt to get the Americans, especially the Commonwealth Edison Group, to pay a royalty on his reheating patent which they were then starting to use. He succeeded to such a degree that the Americans paid up handsomely and the money was invested for Ferranti's children in Samuel Insull's Company, a large part of it being lost in the subsequent financial misfortunes of that concern.

Both feed heating and reheating as primitive ideas are much older. The virtues of feed heating were discovered by trial and error mainly in relation to the treatment of lime bearing feed water. It had already been common practice for at least fifty years to generate power in the Lancashire cotton industry by means of relatively high-pressure engines (say, 50 lb to 80 lb per square inch), exhausting at slightly above atmospheric pressure into the copper cylinders of textile drying machines, so that it was argued that the power to drive the machine was obtained for virtually no additional coal. Later on, with lime bearing feed water, it was found advantageous to heat the feed water up to a comparatively high temperature, i.e. anything up to 300 deg. Fah., to allow the solids to separate out in a separate vessel prior to feeding the water to the boiler, which was usually of the Lancashire type. It was obviously an advantage to do some of the water preheating by means of the exhaust steam from a high-pressure cylinder, the remainder of the heat being obtained either from live boiler steam or by means of a Green's economiser. This is unquestionably a form of true regenerative feed heating. There is evidence that Weir's and Normand's in France both applied these advantages to ship propulsion, associated, of course, with multiple expansion reciprocating engines ; but it is not clear whether they were motivated by fuel economy or by feed water treatment problems.

It is significant that Parsons, with his tremendous energy allowed very little time to elapse between the conception of an idea and its accomplishment. The fierce drive with which he apparently pursued everything he did from about 1880 to about 1910 is one of the most remarkable of his characteristics. It is quite unthinkable that if he had conceived steam reheating and feed heating in their modern forms, these notions would have lingered so long as they did, being ultimately accomplished first by another turbine manufacturing firm. To have made experiments with steam reheating in about 1900—presumably on one of the Elberfeld machines which were the first compound turbines he made—would have necessitated the establishment of a reheating boiler ; this at a time when most of the stations he had already equipped, viz. Forth Banks, Cambridge and Scarborough, were equipped with Lancashire boilers. Actually, reheating in a primitive form from the ingoing steam was introduced many years earlier by E. A. Cowper. Furthermore, all the early Parsons installations had superheater trouble, and it is recorded that after a year or two of trouble at Cambridge the superheaters were cut out and the plant functioned perfectly well without superheat. It is not likely that in these circumstances he could have been enamoured of furnace reheating.

It is true that at this time Parsons was acutely conscious of the need to improve thermal efficiency, but his efforts in this direction were almost entirely devoted to improving the vacuum. His invention of the vacuum augmenter, which gave a further 1in of vacuum above the best conceivable by conventional methods and with surface condensers at that time, arose directly out of this. Heat drops were so small at the time that improvement in the vacuum gave the best and quickest improvement in thermal efficiency. It was only in his later years that Parsons admitted that the only further hope of improvement was to " go up " ; he meant, of course, in temperature and pressure, but he never pressed the twin ideas of " Carnotising " the cycle by the introduction of step-by-step regenerative feed heating in the modern fashion, or by the adoption of multiple reheating—the two ideas which were the outstanding contributions of S. Z. de Ferranti to steam power engineering. It was apparently only about the year 1924, after the significance of the design of the North Tees power station had sunk in, that the firm of Parsons agreed to be associated with reheating turbines, and at least. one 40,000kW machine designed for this mode of operation was installed at the then new Barking " A " power station. There is, however, some doubt as to whether it was ever operated as a reheating machine.

There need be no regrets that the credit for the modern steam power station cannot go exclusively to Parsons. One need only remember Sir Alfred Ewing's tribute :

" Long before he died the world recognised

that he had revolutionised steam engineering. He had taught us how to generate power on a scale and with a concentration never before approached. Nothing, in a sense, could be simpler than his steam windmill with its successive rings of vanes, each in turn taking up a small fraction of the whole energy of the blast. To conceive such a device was one thing, to give it being and action was quite another. That meant many subsidiary inventions and years of toil ; it meant the removal of mountains of prejudice. But the triumph is complete."

One of the most remarkable features of that invention was the notion of making the fixed and moving blades identical, and thus introducing the idea of 50 per cent reaction, which is now recognised almost universally as the most efficient arrangement—especially in gas turbine engineering, and for axial-flow compressors as well.

There is reasonable doubt, however, whether your opinion that he will be considered the "greatest of them all" will in fact be substantiated. A similar statement was made in the *Journal of the Institution of Mechanical Engineers* for June, to the effect that "Parsons was probably the most original British engineer of all time." The really great of any age are recognised as such by their contemporaries, and this was most happily and properly so of Parsons ; but in the perspective of history, contemporary or near-contemporary opinion is, by the nature of things, unreliable. In saying this one remembers the achievements of I. K. Brunel, and, further back, of James Watt himself. Watt's invention of the separate condenser produced the spectacular effect of reducing the coal rate of a Newcomen steam engine to about a quarter of what it had been before. Even Parsons' invention of the multi-stage expansion process with 50 per cent reaction blading can only at the best equal this in its beauty and subtlety of mind. All Parsons' subsequent work was devoted to the consolidation of this one brilliant, central idea. James Watt, with equal persistence, and probably in the face of greater difficulties, went on to produce his second master stroke of genius, viz. the invention of so-called "expansive working," in which he described also his own idea of the properties of steam near enough to what was revealed by Regnault's experiments some sixty or seventy years later to greatly improve further his already remarkable steam engine.

Nothing of what I have said is intended in the slightest degree to detract from the greatness of Parsons' achievements, but it is essential to be fair to the memory of Ferranti, who showed extraordinary inventive genius both in electrical and thermal power engineering, and who was mainly responsible for adding feed heating and furnace reheating to the modern steam power plant.

J. F. FIELD

Edinburgh,
June 14th.

FRENCH LOCOMOTIVE EXPERIENCES

SIR,—Mr. Livesay's entertaining account of his experiences with French locomotives will have given pleasure to many readers. It takes me back in memory to similar articles on the same subject published by THE ENGINEER at the beginning of the century. Those articles were written by my old friend, Charles Rous Marten, who died in 1908, and it is good to find two observers, so far apart in time, at one in their admiration for French locomotive work and in their appreciation of the courtesy and friendliness with which they were everywhere received.

At the Paris Exhibition of 1889, I saw various French locomotives, including that strange-looking freak, the "Estrade," a 0–6–0 with a four-wheeled tender, all the wheels of both engine and tender being 8ft in diameter, and one came away with the impression that locomotives of other countries had nothing to fear. But at the exhibition which followed in 1900, where the de Glehn "Atlantic," attracted most attention, the position was very different. By then French compound engines had acquired a leadership which they have never since lost, and if the change to electric traction is now bringing their career to a close, the story of their evolution during the last sixty years is one of which French engineers have good reason to be proud.

W. B. THOMPSON

Athenæum,
London,
June 15th.

Literature

Dimensional Methods and Their Applications. By C. M. FOCKEN. London : Edward Arnold and Co., 41, Maddox Street, W.1. Price 30s.

IT is just over a year since the publishers of this book produced Professor W. J. Duncan's *Physical Similarity and Dimensional Analysis* (THE ENGINEER, May 29, 1953). Inevitably there are comparisons, and Dr. Focken's book has the handicap of coming after so masterly a work, without its author having had the opportunity to profit from it. Nevertheless, although he has not the crisply lucid style and verve of Duncan, Dr. Focken has written a book that is in no way negligible and fulfils a valuable, and different, purpose. It is a pity that the use of the words "methods" and "applications" in the title lead the reader to expect a textbook on the use of dimensional analysis instead of a work concerned more with the foundations of the subject, the philosophical—if not metaphysical—concepts involved and their consequences as a contribution to the understanding of physical reality. Research and development engineers, who wish to make use of dimensional methods in their work, must have due regard to the necessary physical similarity to make such methods applicable, but need not be unduly worried by the impossibility, according to the theory of relativity, of making simultaneous measurements or determinations; they will accordingly find Duncan's book ideally suited to their requirements. In spite of Dr. Focken's appreciative quotation of Heaviside's famous rhetorical inquiry, "Am I to refuse to eat because I do not fully understand the mechanism of digestion ?" the practising research worker will receive little practical guidance and that embedded in much rigorous exposition which is heavy going for the user, as distinct from the student, of dimensional analysis. It will be gathered that this is a difficult book, requiring considerable concentration to follow the argument ; it is the more unfortunate that it is produced, apparently by lithography, using a fount which is particularly hard to read, so that the attention is distracted by the typography ; in this, again, the book is in marked contrast to the beautifully clear and legible type face employed for Duncan's book.

Those who are interested in the foundations of dimensional analysis, however, will read Dr. Focken's book with considerable profit : for too many dimensional methods are a form of magic incantation by which in favourable circumstances a mass of data uncritically collected from ill-planned experiment may yet be made to yield a worthwhile result. Although it is not necessary for every student to be conversant with the basis of the method, it is essential that its teachers should be adequately grounded and clearly able to show the limitations, applicability and value of it. Here are to be found marshalled the proponent views of Bridgman and Buckingham, the disputant replies of Campbell and O'Rahilly, the philosophical investigations of the meaning of the words "fundamental" or "basic dimensions" to which Dingle has contributed so much valuable thought, and the difficulties inherent in the extension from straightforward mechanical problems to those involving thermal, electrical and magnetic magnitudes.

The book is divided into a short introductory chapter and four others ; the introductory "Elementary Treatment of Dimensions" is mostly on the familiar lines with rather more than the usual emphasis on the arbitrariness of the choice of mass, length and time as fundamental units ; it is therefore, surprising to read that "in engineering, where convenience is a greater consideration than precision, the units of length, time and force are often used as the three fundamental units." This chapter is almost superfluous and can be skipped by those who are already familiar with the general aspects of the subject. The next, entitled "Dimensional Analysis or the Method of Dimensions," is really the crux of the book ; disarmingly, Dr. Focken opens it by saying "As the author has set out to write a book which will show readers the practical advantages of the uses of dimensions, it is injudicious to attempt any form of rigorous treatment which would seem heavy or unwieldy to engineers and practical men." He then goes on to give an exposition of the subject which may not satisfy his own exacting standards, but is nevertheless unusually rigorous and gives a sound foundation to the subject ; the discussion is based on twelve postulates which are explained : (1) a *physical quantity* is anything that can be measured by a strictly definable process. (2) A *measurement* of a physical quantity consists in principle of its comparison with an arbitrarily chosen *unit* so that the result is a *magnitude*, i.e. a numeric times the unit. (3) Measurement must be by some particular method whose specification is understood. (4) Magnitudes are either *fundamental* or *devised ;* a fundamental unit is the property of a system which is arbitrarily stated to have unit magnitude and must be susceptible of physical addition ; a derived magnitude has its numeric changed by a change in the units of the fundamental magnitudes and may not necessarily be susceptible of physical addition (we cannot add viscosities as we can lengths or electric currents). (5) The number of fundamental magnitudes is arbitrary and their choice is a matter of convenience. (6) A derived magnitude can be expressed in one way only in terms of the magnitudes of the fundamental quantities. (7) Physical equations may (*a*) *define* derived magnitudes *or* (*b*) express *experimentally* established physical relations. (8) Any valid physical equation must be homogeneous in the fundamental magnitudes. (9) The power to which each fundamental magnitude occurs in the reduced expression is called the *dimension* of that fundamental magnitude in the corresponding term. (10) Dimensions are characteristic of magnitudes not of the physical quantities themselves. (11) Physical equations may contain constants ; in *definitional* equations these are arbitrary and dimensionless ; in *experimental* relations they are not arbitrary and may have dimensions. (12) Physical equations are valid whatever the sizes of the units chosen. This, then, leads to a discussion of the number of fundamental magnitudes required for mechanical problems, the meaning of dimensional formulæ and Bridgman's proof, from the postulate that relative magnitude has absolute significance, of the theorem that every derived magnitude must be expressible as the product of some constant and arbitrary

powers of the fundamental magnitudes. After studying the complete equation, which remains true for all choice of size of fundamental unit and the meaning of experimental constants, the Pi theorem and the general and special methods of dimensional analysis are treated analytically and the principles of similarity briefly touched on ; O'Rahilly's "Measure-Ratio Method" is treated fairly fully.

Having considered the general principles, Dr. Focken devotes the next chapter to the extension of the method, principally to thermal, electrical and magnetic magnitudes and discusses some of the difficulties and criticisms arising from these extensions ; this part concludes with a summary of the general criticisms of dimensional methods of Campbell and O'Rahilly and the rejoinders of Buckingham and Bridgman. The mechanical engineer or any others who are not interested in electrical measurements should not skip this part ; not only does it bring home the difficulties of saying that the physical quantity Q has dimensions so-and-so, only to find that these are a function of the choice of fundamental magnitude, but also because some important philosophical considerations not restricted to electricity or magnetism are to be found here. For example, Scott Blair's paradox that the dimensions of a rheological property of materials may vary from one substance to another is here explained by a quotation from Dingle : "It is true that the dimensional symbol represents the process of measurement and is the same for all applications of the process ; and it is also true that the dimensional symbol satisfies the condition that physical relations shall be independent of the units of measurement, which requires them to be expressible in terms of simple products of powers of the fundamental magnitudes. What is not true is that the form of the symbol which meets the first requirement is necessarily the same as that which meets the second."

The final two chapters concern physical and engineering applications respectively. The former deals not only with such problems as the frequencies of a vibrating string, but includes an interesting discussion of the interrelation between the constants of fundamental physics, such as the velocity of light and Planck's constant. The last chapter is of the most direct interest to an engineer, but the discussion is philosophical rather than mathematical or practical. The problems dealt with are : (1) mass of objects from mass of model of different material, i.e. the pattern-casting relation, but with the examples of a clay model of a granite monument ; (2) the screw propeller model and full-scale relation ; (3) ship and aircraft scale model relations, including effects of compressing air, &c.; (4) a very brief note on the dimensional analysis approach to the minimum weight for maximum strength relation in structures ; (5) miscellaneous model tests, including the ventilation of the House of Commons ; (6) the strength of the earth as a whole ; (7) pipeline flow ; (8) a note on the stiffness of beams, and (9) certain heat transfer problems.

Industrial Training for Manual Operations. By W. DOUGLAS SEYMOUR. London : Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 20s.

IN order to determine its potential value to the engineer this book requires very careful reading, seeing that its avowed object is "to provide the manager or supervisor in industry with an outline of the mental and bodily processes involved in the acquisition of industrial skill." But by the time the fourth chapter is reached the average manager would probably conclude that the book is more likely to be of value to the theorist than to the practical man, even though it contains the result of much painstaking experiment and acquired experience. When he reads that in machine operations it will be noted that "the experienced worker makes better use of the sensory data, in particular, in a greater proportional use of tactual and kinæsthetic than of visual data," he may begin to feel that the subject matter is beyond his comprehension. Indeed, as we near the end of our perusal we find the author confessing that "in this book there are many long words and some complicated ideas," and we are inclined to ask him whether this is really necessary. He suggests that some may prefer to read Chapters V to VIII before Chapters II to IV, and we think the engineer would do well to adopt this suggestion. He will then be concerned more with the practical side of preparing a specialised training course, what has to be taken initially into consideration, the correct use of the anaylses that have been made, the way in which the actual training in the various operations should be undertaken, and also a careful investigation as to what trainees should be expected to know as to the work and its quality.

Although the author has evidently primarily in mind factories engaged in the manufacture of hose, fabrics and the like, the general principles can be applied to engineering works, especially those on mass production, and the manager will find much to interest him and perhaps help him to realise that there is a great deal which he could do to increase the output of the factory under his control. The later chapters deal with the setting up and operating of a training centre which we are told should be quite distinct from the main factory and have its own specialised staff, the chief, called the training officer—we should prefer superintendent—being given the rank of a departmental manager. Mr. Seymour rightly suggests that a trainee should receive a friendly introduction, and be then taken for a run round the factory before assuming his place in the training centre, where he will soon be convinced of the necessity for having a complete knowledge of the work to be undertaken, and the methods and materials to be used, while a realisation of the quality requirements is essential. At this point it might be well to raise the question as to how many firms can afford the luxury of a separate training centre. Perhaps the answer will be found in the last chapter, where the economic side of specialised training is examined, and examples given of the increase in production that has occurred, then when we read of 60 to 80 per cent increase, with its attendant beneficial effect on costs, we can probably call to mind factories where such a centre should be regarded not as a luxury, but a necessity. But before coming to the last chapter four intervening ones should be mentioned, treating respectively with the attitudes and procedures in operator training, the training of instructors—a most important matter—the organisation and supervision of the centre, and the question of retraining. Having come thus far the reader will perhaps better appreciate the value of the earlier chapters, which consider in a more theoretical way the subject of industrial skills, and how they may be acquired, with some of the newer and more scientific methods of imparting skill. The author contends that "the skilled operator should be valued as highly as those of professionals in the field of sport," and if so, it is incumbent on us to give him the fullest advantages, privileges, and assistance. An interesting appendix gives in detail an example of a suitable training course, which was exhibited by the Ministry of Labour at the Festival of Britain under the title "Pauline Learns Linking," dealing with seamless hose, an operation requiring great dexterity and precision ; this appendix is well illustrated by eight half-tone plates.

This work bristles with points which might be criticised, and this is realised in a foreword by Professor Matthew, of Birmingham University, who indicates that the author is not biased in regard to controversial problems as might appear, but has rather been impressed with the desirability of keeping his exposition as concise as possible. We cannot help feeling he is very unwise to place the training centre under the jurisdiction of the personnel department, for surely it is essentially concerned with future production, and should accordingly be attached to the works manager who can do much to interest foremen and other executives in the welfare of the trainee who will eventually come into the workshop. Again, we should have expected Mr. Seymour to have made much more use of the educational film, particularly in demonstrating movements which are too rapid to be followed with the eye, but which can be filmed and then passed across the screen so slowly that the significance of each motion can be intelligently appreciated. In this way what takes place when a shell leaves the muzzle of a gun can be demonstrated in a way formerly quite impossible.

Mechanisation and other factors contribute to increased productivity, inferentially stressing the necessity for developing industrial skill, and certainly Mr. Seymour has clearly indicated the means of acquiring such skill by instituting a suitable system of industrial training, and this book gives us an insight into an orderly approach to an important subject.

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Raw Materials for Electric Cables. By A. King and V. H. Wentworth. London : Ernest Benn, Ltd., Bouverie House, Fleet Street, E.C.4. Price 42s.

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Heat Transfer. A symposium held at the University of Michigan during the summer of 1952. London : Oxford University Press, Amen House, Warwick Square, E.C.4. Price 40s.

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Industrial Diamond Trade Names Index. Fifth edition. Compiled jointly by Industrial Diamond Information Bureau and *Industrial Diamond Review.* London : N.A.G. Press, Ltd., 226, Latymer Court, Hammersmith, W.6. Price 3s. 6d.

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Seat Hardness of Flow-Control Valves

By DONOVAN H. FALLOWS

The Canadian market is of growing importance to a number of engineering firms in this country. The author here draws attention to the circumstances, differing from those in the United Kingdom, under which valves are used in Canada. He recommends in particular the fitting of hard valve seats, not less than 500 Brinell, and has certain other pertinent remarks to make about the design of valves, from his experience as an engineering executive.

THAT British engineering equipment is usually of the highest calibre no one will deny. It is, therefore, one of those difficult problems to face when one must call to account the misuse of individual ancillary equipment on British manufactured plant installations, especially in view of the fact that the engineers may have had no difficulty with the same equipment elsewhere. But that this is true is only too obvious to all those working in North American industry, who have had good machinery and performance marred by flow-control valves unsuitable for local conditions. Not only British manufacturers are at fault, however, for it is only of very recent years that controls with suitable wearing faces have been distributed by North American manufacturers.

The writer, for three years, constantly agitated his head office and factory for the general manufacture of a seat ring and disc valve of seat hardness and design suitable for the wire-drawing and chemical actions constantly met in the Canadian process industries. It was not until there was brought to bear the combined pressure of consulting engineers, and consumer engineers, that the designing staff decided to put into production a seat ring and disc assembly which would meet this heavy-duty work, and this valve has been a complete success in the pulp, lumber, canning and dairy industries, beyond the expectation of the manufacturers. Other manufacturers of control equipment have come to the same production decisions, to meet the control problem.

The conditions to be met in the majority of mills in North American pulp and chip production are varied, but with some dominant problems common to almost all. The mills are usually away from cities, often miles from any metropolitan or municipal water supply, the water source being the private intake from one of the rapid erosion rivers so common in the North American scene. The first problem, therefore, is the fact that upland collected water is usually of high mineral content. Not only that ; it has micro-granular suspensions of non-soluble minerals, which give excessive abrasive action on the hydraulic controls and equipment. Shear damage and scarring of seating surfaces are excessive in the gate and globe-angle valve group. Secondly, the common use —more prevalent than in the United Kingdom —of wet steam, often of high velocity, leads to excessive wear, and is the greatest cause of wire-drawing on the fine control lines, where the valves are used throttled. Also, with many plants converting to superheat on a part-plant basis, there is a considerable temperature drop differential on the reducing and trap units. Thirdly, the labour working the machines is usually unskilled in category, sometimes women, especially on the take-off end. These people tend to forget that the handling of all valves and cocks needs positive action, with the result that the pipe fitter's job is one of constant repair, replacement and regrinding, due to the damage of seat and disc and spindle metal from valve bleed.

To look at the picture as a whole, one can see that much trouble and expense could be saved the plant engineers by suitable design of valves on all plants and machinery exported, the manufacturers taking more note of the valve specifications. In one instance alone, the writer witnessed, personally, a newly installed plant where the drum roller drying cylinders' manual steam feeds, valves of 300 S.W.P., 550 deg. Fah., body design, with 285 deg. Brinell hardness, Monel metal, seat rings and discs, cut and wire drew so badly that within a few weeks of installation they required new seats and discs, which again had repeated upon them this destructive performance. The valves, it may be added, were of leading manufacture and of naval pattern bronze body and trim.

On consultation with the managing, engineering and fitting staff, it was recommended by the writer that the valves be replaced by a similar pattern, except that cone-plug seat and discs be fitted, of a stainless steel of over 500 Brinell. This secondary installation so soon on the original, incurred a considerable additional expense to the company, and it was of major concern to the management. However, this installation proved completely trouble-free, and the machinery subsequently worked at a high-efficiency ratio, even standing up to the mishandling of unskilled operators. Bleed damage was negligible. It is gratifying to know that this particular problem can be forestalled at installation, by correct specifications on the drawing board.

The requirements, therefore, of all controls (manual) on pulp machinery, in the bronze line, should be a cone-plug style globe or angle valve on all adjustable control lines, and the seating surfaces should be of minimum 500 Brinell stainless steel. The next requirement is that spindle metal should be of a high-tensile Toban bronze or stainless hard metal, even steel in some cases. Correct selection on the metallurgy of the assembly is important, to avoid electrolytic effects. Check valves should be of a positive, semi-cushioned action, regrindable, of Monel, or similar seating, and in some cases spring loaded. Quick-action valves are common on the hoists, and hydraulics, as well as some steam lines. Usually, the common high water pressure makes the use of quick-action gate valves difficult due to water hammer. Spring-loaded, quick-action, cushioned globes prove to be the most satisfactory, though not easily arranged for line use on the take-off end. Here properly designed extension hand-levers can save body distortion due to added substitute extensions. The dashpot style of cushioning the seating is definitely the more acceptable pattern, and a design which most British valve manufacturers could do well to imitate when planning their export of plants and ancillary equipment.

It should be pointed out to designing staffs of manufacturers that gate valves do not meet with much approval by Canadian inspection authorities, when on steam and major control lines. The excellent Inspection Board of British Columbia, under Chief Inspector Donald Denham, set out specifically their requirements in their rules, and are always prepared to make known these specifications to manufacturers and to assist them in their design for the Western Canadian field.

As a result of private research and inquiry into the British manufacturers of pulp and paper machinery and into some valve manufacturers, it can be said that only three pulp machinery manufacturers afforded evidence that they specified the valve requirements for export, or approached the plant engineer for his specifications. Others showed little concern with valve specifications, leaving it entirely to the valve manufacturers to supply valves for the installation. Nearly all used valves of makes that do not provide parts replacement on the North American continent.

The writer is indebted to the British Engineers' Association, and to the managing director of a leading Scottish manufacturer of machinery for paper, rubber, milk and of machine tools, &c., for information relative to local water conditions in Great Britain ; to the technical manager of a Midland manufacturer of machinery for pulp slurry, and to the great assistance on valve design and usage by the chief engineer of a development corporation in Middlesex. That these leading companies should be concerned with this problem in North America and Europe is indicative that more stress should be laid on the selection of control equipment, not only in the pulp and paper industry, but in all processing and industrial plants, here and overseas. At this time of British dollar shortage, and Canadian expansion, more consideration should be given to overseas requirements, in engineering, with the certain reward of an increased export trade.

Suez Canal Company's Report

AT the annual general meeting of the Suez Canal Company, held recently in Paris, it was reported that in the past financial year the amount of traffic through the canal had continued to increase, the increase being at a greater rate than that recorded for 1952. Both the number of transits and the tonnage, on which the dues are assessed, shared in the increase the rise being greater with respect to tonnage than transits. During 1953 transits totalled 12,731, representing an aggregate of 92,905,439 tons net Suez measurement, the volume of traffic having increased by 7·9 per cent compared with the previous year, the major portion being due to oil tankers. It was noted at the meeting that the southbound cargo traffic had risen by only 2·3 per cent, whereas the corresponding increase in northbound traffic was 10·5 per cent. The figures, it was stated, illustrated the importance of the canal and emphasised its fundamental role in world economy. Due to the rise in the volume of traffic both receipts and expenditure had risen but the overall figure represented a considerable increase in profits. Based upon this fact and the tradition of the company to share prosperity with its clients a reduction in transit dues was announced, but it was made clear that the reduction was provisional and that the new rates would remain in force for one year. The programme for deepening the canal by 20in, which has been going on for five years, is only proceeding slowly due to heavy silting taking place. Owing to the rate of progress it is still not possible to state when the transit draught can be authorised at 35ft as a step to a maximum of 36ft which it is hoped to attain eventually.

Magnetic Tape Control of Machine Tools

During the past few years development work has been carried out using magnetic tape recordings for the automatic control of machine tools. In connection with its work in this direction some interesting notes have recently been issued by Alfred Herbert, Ltd., and the abstracts from these notes which we reproduce are accompanied by particulars of a fine boring machine to which the control system has been applied.

A COMMUNICATION has been received from Alfred Herbert, Ltd., of Coventry, giving particulars of a system of automatic machine tool control using magnetic tape recordings, which it has developed after two years' experimenting. Before dealing with the firm's system of control and a precision boring machine to which it has been applied, the notes state briefly the principles involved in making a sound record on magnetic tape and the ways in which the tape can be used to control machine movements. For the benefit of those less familiar with the magnetic tape sound recording principle, we reproduce these brief introductory notes.

When sounds impinge on a microphone, the vibrations produced cause minute electrical currents to flow which are amplified and are fed to an electromagnetic recording head. If a plastic tape having a metal oxide film coating on one side is passed at a constant speed through the varying magnetic field of the recording head, the tape becomes variably magnetised in proportion to the original sounds. On "playback," the magnetised tape passes the playback head and induces varying currents which are amplified, fed to a loudspeaker, and eventually appear as sounds again.

If, then, some method is devised for converting machine movements to such a form that the magnetic field of the recording head can be varied in a fixed relationship to the original movements, the preservation and reproduction of a machine cycle are as easily dealt with as music or speech. Various systems such as the use of the unusual characteristics of Selsyn motors, are being investigated to give electrical signals of positions and speeds. The Selsyn motor can act as an electrical "generator," and when its shaft is rotated by some external power a signal which is a reference of its angular rotation is produced. If a servo motor is used for driving a machine slide, which, in turn, is driving a Selsyn, then, by means of auxiliary apparatus in which is balanced the signal from the Selsyn, the servo motor can be made to run only for as long as a difference exists between the signal from the Selsyn motor and the reference in the auxiliary apparatus. As soon as the difference is eliminated, the servo motor will stop. This accuracy is consistent to within ten minutes' angular rotation. In the above system the recorder "memorises" these patterns and measurements of movement.

Another method of control requires the reduction of the machine functions to coded data by digital computors, whence it is fed into the recorder as a series of pulses. With this system, however, the loss of one pulse out of perhaps hundreds of thousands may destroy, or at least produce inaccuracies in, the work.

In the system with which Alfred Herbert, Ltd., has been experimenting, the equipment is kept within reasonable proportions and the risk of losing a signal is eliminated. Also, the design of the recorder is particularly simple. It should be remembered that the recorder was originally developed to record faithfully complex combinations of frequencies (such as those obtained when a large orchestra is playing), and all these are intermingled on one track only. It seemed, therefore, only natural to exploit these principles. Thus, machine movements are converted into frequencies which can be heard as musical tones if the output from the recorder is applied to a loudspeaker.

The electrical system shown in Fig. 1 is of the firm's prototype equipment and the recorder used is a standard commercial unit. This equipment was applied to a Heald "Borematic" fine boring machine, which was chosen because of its obvious suitability for demonstration. Most machines of this type have one cycle of operation and the pattern of the machine functions is normally obtained by conventional electrical methods. Quite often, the cycles necessitate fairly intricate circuits and a large number of limit switches and relays. Obviously, the more complicated the circuit, the more difficult it is to change or vary the cycle on the same machine. The magnetic tape control equipment developed reduces the work involved in changing a cycle to an absolute minimum and any cycle within the capabilities of the slides and elements provided on the machine can be reproduced without altering the control circuit or the machine. The only limit to the length of the cycle that can be recorded is the length of tape accommodated on a standard reel. The tape shown in the illustration has a playing time of one hour.

The conversion of the machine shown in Fig. 2 was very simple—all the limit switches and relays were removed, retaining only the main hydraulic motor and starter and the solenoid-operated valves. The solenoid valves were connected direct to the slave relays which are actuated by tuned reeds or tuned frequency circuits. Each of the reed relays or tuned frequency circuits is responsive to only one frequency and each machine function has a separate controlling relay. The frequencies are generated separately by oscillators and these work continuously.

When a certain machine function is required, the appropriate push button is pressed, which allows an electrical feed of the correct frequency to complete the circuit to the reed relay, which operates the slave relay controlling the solenoid valve. At the same time—and for the same length of time that the button is pressed, the frequency is impressed on the magnetic tape. At the end of the movement, the button is released and the recording is interrupted. This procedure is followed to record all the machine movements. If the machining operations allow a number of movements to take place simultaneously, the total combination of frequencies can be as easily recorded. When the cycle is completed manually, the signals of each movement are locked together inherently in the tape.

When the machine and the recorder are returned and rewound respectively to their starting positions, the recorder can be "played back" automatically so that the frequency responsive circuits, after sorting out the signals into their correct channels, operate the solenoid valves in their original manual sequence and so reproduce exactly the operational cycle.

If a mistake is made whilst a recording is being made, the tape and machine can be returned to starting position, the original signals "wiped out" and a re-recording taken. If a mistake occurs at the end of a very long cycle, it is necessary only to "wipe out" the signal of the movement on which the mistake was made. In addition, the tape can be cut and spliced and movements eliminated if not required.

It is unnecessary to have a separate track for each machine movement, any number of different signals being accommodated on one track of the tape. Apart from the advantages already mentioned, it will be appreciated that if failure occurs in the recording "playback" circuit or in the tape itself, then all movements of the machine are stopped, whereas, if the system used separate tracks, it would be possible for some of the movements to continue without reference to breakdown of, say, the "playback" head on another track. The actual process of recording automatically erases previous information and there is no risk of accidental superimposition of a new cycle on top of an old one.

The Heald machine was arranged to finish a special component to demonstrate the increased

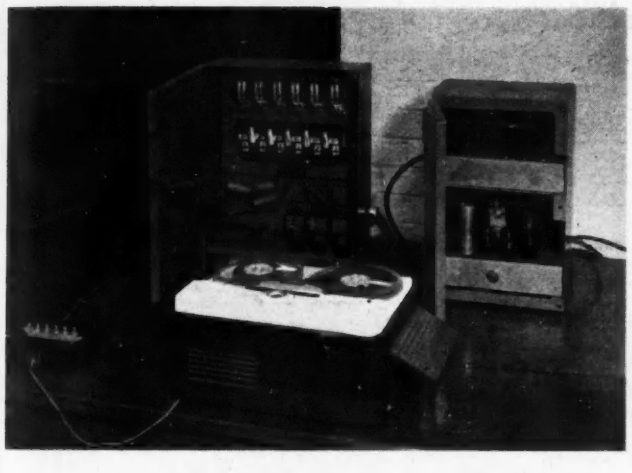


Fig. 1—Magnetic tape control equipment for use in connection with a fine boring machine

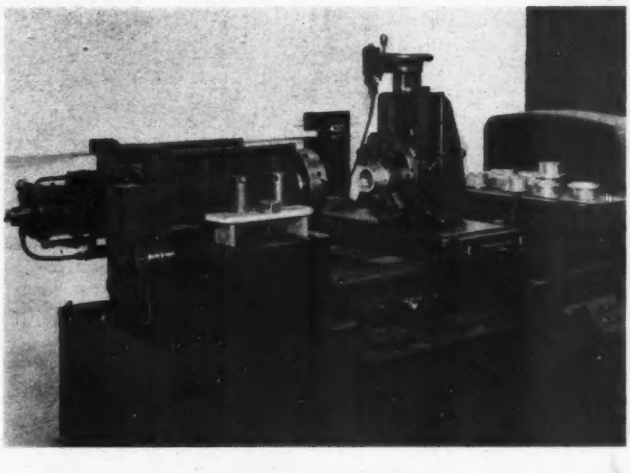
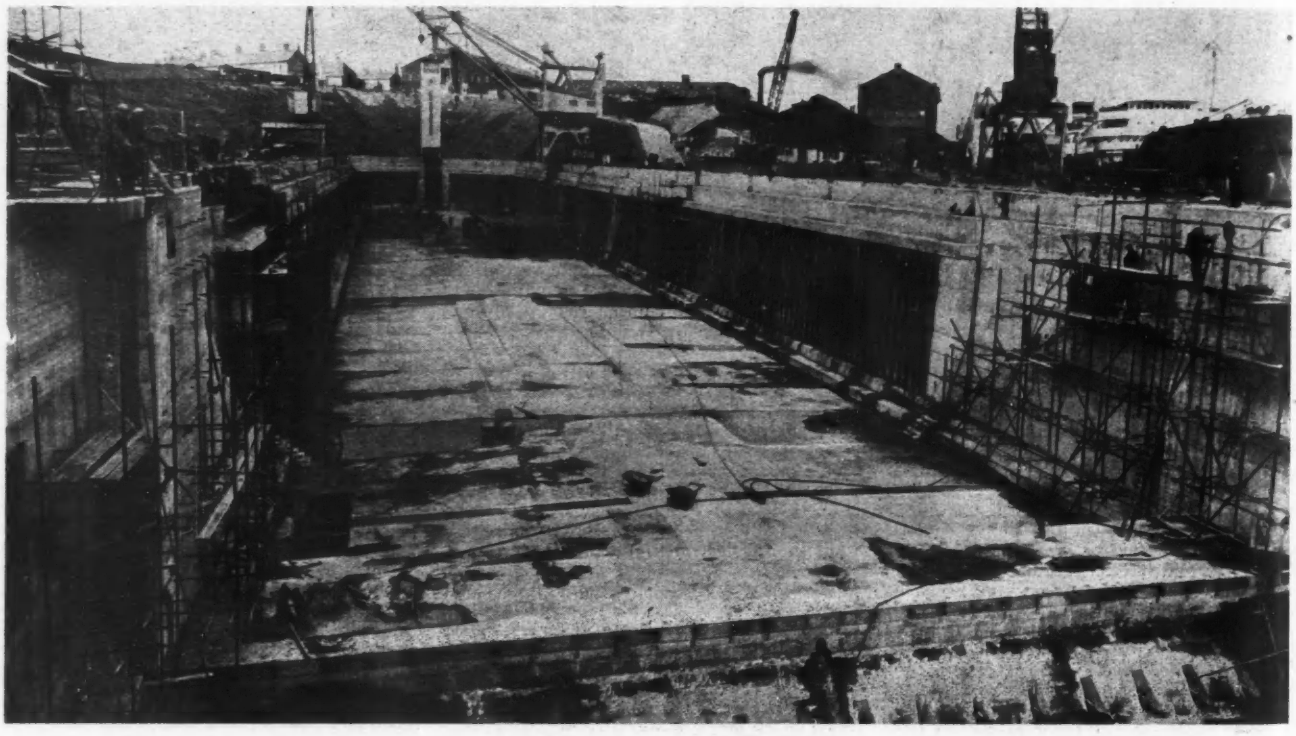


Fig. 2—Fine boring machine arranged for magnetic tape control which gives three cycles on a machine previously used for single-purpose work

DRY DOCK AT NORTH SHIELDS

The completed dry dock, which is 709ft. in length, 95ft. wide at the entrance and has a depth of 27ft. over the sill at H.W.O.S.T.



The dry dock approaching completion ; this illustration is reproduced from a photograph taken from the arched cofferdam built at the dock entrance

versatility with the new control. Three different cycles of operation were used to machine the component which would normally be impossible, or extremely difficult, to do on one machine not equipped with a magnetic tape control system. The cycles of operation and component machined are shown in Fig. 3.

The extreme accuracy required in machining is obtained on the Heald machine by the use of dead stops, and dependence is not placed on the tape and its associated control for accuracy of machine movement with respect to the exact time the tape is playing. The system, therefore, is used as a method of recording and reproducing patterns of machine behaviour and not of absolute measurement. The dimensional accuracy of the final machine movement is an inherent function of the machine. Before recording, the hydraulic circuit is preset to give certain rates of feed and the recorded signal ensures that the slide squeezes against the dead stop with the hydraulic oil viscosity at its lowest. It is not economical to make the tape an absolute reference of measurement on the above set-up, or, indeed, on any machine where accuracy can be defined by dead stops.

It is considered that any kind of machine now actuated by electro-responsive devices, such as

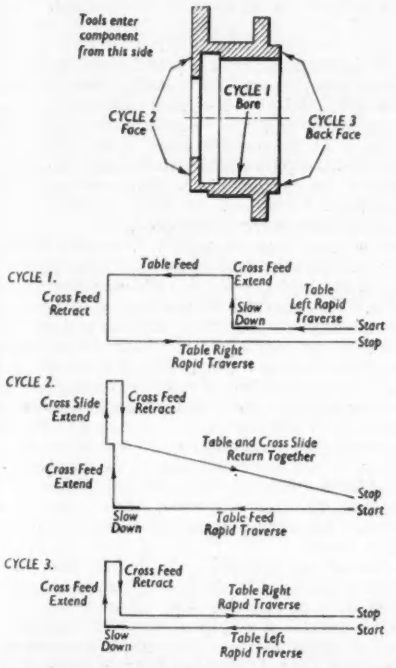


Fig. 3—The three different cycles of operations automatically controlled by the magnetic tape control system on the "Boremaric" for machining the component shown

solenoids, magnetic clutches and servo motors, could be operated by the system described and new work could be easily accommodated without complete revision of shop planning, layout or alteration to the machines. It is not suggested that it would always be an advantage—or even desirable—to convert all single-purpose machines. But many machines are idle for long periods when a change in the design of a component or a new component necessitates an alteration to a machine cycle, and in such cases the advantages of conversion are obvious. A further application of the system would be to profiling and three-dimensional contouring. Large models could be dispensed with and the form preserved on the tape and filed as easily as a drawing. This application would be most efficient if the tape could be programmed away from the machine, and, at first sight, it would seem attractive to record the sequences for all types of machines in this way, i.e. direct from drawings rather than on the machine itself. Unfortunately, the difficulties involved are many, and the result would not always be justified by the complexity and cost of the extra equipment. Furthermore, it is considered doubtful whether it is possible to improve, or even equal by simulated techniques, the quality of work produced by a skilled operator. Each type of machine has certain characteristics which are exploited by a skilled operator, but which do not enter into mathematical computations. There are very few components which cannot be produced on a machine by manual operation. The sum total of the movements involved may produce a complicated sequence which would be out of the question for normal working, but the individual operations could be broken down and performed in slow motion for recording. If necessary, the tape could be stopped whilst the next sequence was planned or the tools finally set, and on "playback" the auto sequences speeded up to the machine's correct operating speed.

The company points out that the possibilities of magnetic tape systems are wide and it may be some time before their advantages are exploited to the full, but savings can undoubtedly be made by application to modern machine tools.

Dry Dock on Tyneside

We illustrate on page 936 a dry dock which has recently been completed for Smith's Dock Company, Ltd., at North Shields, and was officially opened by Mr. J. P. L. Thomas, First Lord of the Admiralty, on Friday, June 18th. At a luncheon after the opening ceremony Mr. Thomas commented upon the shortage of dry docks in the United Kingdom and of the tendency to increase the size—and particularly the beam—of merchant ships; the new dock, he said, would take the larger dry cargo ships and 95 per cent of the tankers in commission or on order.

The new dock is 709ft long, 95ft wide at the entrance, and has a depth of 27ft on the sill at high water of ordinary spring tides. The dock walls consist of a heavy section of steel sheet piling, anchored at coping level, and the dock has a massive concrete invert. This steel sheet-piled construction is a novelty in dry dock design and is claimed to be more economical than mass concrete. The piles were driven at an early stage in the construction, and some difficulty was encountered due to the presence of boulders, so that trenches had to be excavated before the piles were driven. After pile driving, the central part of the dock was excavated and the concrete invert constructed. An arched cofferdam of steel sheet piles, with steel bracing ribs, was built to seal off the river entrance during construction. Excavation totalling about a quarter of a million cubic yards had to be completed, to remove a hillside, before the dock itself could be started. The illustrations opposite show the reinforced concrete lift tower. The lift operates with the lower part of its shaft either dry or flooded and is automatically controlled to prevent travel below the cope when the dock is filled.

The dock has a "Box" gate—a design which is hinged at the base and flaps outwards to open. A gate of this kind and of very similar overall dimensions, installed at T. W. Greenwell and Co., Ltd.'s dry dock at Sunderland, was described in The Engineer of October 17, 1952. Such gates do not require the gate recesses, and hence the considerable length of dock wall, necessary to accommodate mitre gates. The pumping system incorporates a siphon with air valves at the crest, which operate when the main pumps stop so as to prevent water siphoning back into the dock; this device eliminates a costly valve in the main pump culvert.

The project has also included the construction of a deep water quay, 380ft long, which forms an extension to the existing quay. The new quay is also of steel sheet piled construction, comprising a double row of piling, with reclamation behind it. The dock and quay are both equipped with comprehensive services for ship repairing, including, in the case of the dock, cranes up to 30 tons in capacity, and a plater's shed. The cost of the project was stated to be about £1,250,000.

The consulting engineers for the scheme were T. F. Burns and Partners and the main contractor was Holloway Brothers (London), Ltd. The Box gate was supplied by Sir William Arrol and Co., Ltd., and the pumps by Drysdale and Co., Ltd.

Electrical Engineering in World Trade

A paper on "Electrical Engineering in World Trade," by Sir George H. Nelson was presented to the British Electrical Power Convention at Eastbourne on June 15th in the form of a summary read by Mr. H. G. Nelson, in the unavoidable absence of the author. This paper briefly reviewed the well-covered ground of power generation, transmission and distribution, and utilisation; touched upon such specialised applications as traction and domestic equipment, and finally referred briefly to the impact on electrical engineering of new materials, of electronics, and of atomic energy. Abstracts from the paper are reproduced here.

Generation

Hydro-Electricity.—In a world survey it is convenient to deal first with hydro-electricity before reviewing the various forms of thermal power station.

At the 1950 World Power Conference, the world's economically exploitable hydro-electric power resources were assessed at 1100 million horsepower. It was considered that this would probably be capable of development over the next half century. Already developed world hydro-power is estimated at about 90,000MW, so that roughly 12 per cent of the total available is already harnessed. In Canada, the figure is about 23 per cent and the average for the British Commonwealth just under 10 per cent. If installed capacity of hydro-electric plant increased at the rate of 7 per cent per annum (compound), which is a fairly general average for the increase in the total of all forms of generating plant, then the limit of economically exploitable hydro-electric power would be reached in about thirty years. The limit will, in any event, be reached sooner or later, but meanwhile there is plenty of work to be done in this field for many years to come.

British manufacturers were supplying hydro-electric plant to many countries abroad before there was any significant demand at home. In recent years they have been privileged to carry out extensive work for the North of Scotland Hydro-Electric Board. The fact that some of the most modern hydro-electric stations in the world can be seen in operation in this island by overseas visitors is of incalculable value in helping to promote our export trade.

Steam.—According to information published by the Statistical Office of the United Nations, the output from thermal plants grew more rapidly than that from hydro-electric plants between 1929 and 1950, and in 1952 about 62 per cent of the total power generated came from thermal plants, and 38 per cent from hydro and geo-thermal sources. The preponderance of thermal power is likely to continue, and in particular the preponderance of steam generating plant, even if coal is ultimately displaced by nuclear reactors.

With the constant growth of load the size of generating stations has increased, and with it the size of individual sets, both at home and abroad. In this country, whereas thirty years ago a 20MW turbo-set was considered a very large unit, sets of over 100MW individual capacity running at 3000 r.p.m. are now being installed. Consideration is being given to individual units with capacities as great as 250MW or higher for installation in various parts of the world within the next decade.

An important factor in export trading is the interdependence of the home and export markets and the standardisation of units to meet the needs of both. Certain steps have been taken, both on a national and an international basis, towards the standardisation of sizes and steam conditions. It is felt, however, that more could be done in the way of standardisation in general, and that the subject merits a good deal of further study. There is, of course, a major complication due to the 60 cycles frequency being standardised on the American Continent and 50 cycles in most other parts of the world. This inevitably necessitates two separate sets of standards, and to this extent the American Continent has to be treated as a separate entity from the design point of view.

Diesel.—The diesel engine has long been, and

still remains, an invaluable source of power in places where demands are small, supplies of solid fuel are not available at an economic cost, or where water supplies are limited. Such conditions are met with in many parts of the world. For equivalent power, a diesel installation is much more compact than a comparable steam power station, and it does not require the coal handling and water-treatment plant associated with the latter. It also has the great advantage of immediate availability, and for this reason is extensively used as a stand-by plant to safeguard against failure in the main supply, or to carry peak loads.

The diesel has a higher thermal efficiency than any other known form of heat engine, and now also has a high degree of reliability which compares well with other forms of prime mover.

Gas Turbine.—At present the industrial gas turbine is restricted to using a comparatively narrow range of liquid and gaseous fuels, but the possibilities for improving the range of fuels in the near future are good. The most important applications are probably gas line pumping, blast-furnace blowing, peak load plant in association with hydro-electric systems, and coal-burning, base-load plant. Locomotive application may also be mentioned. The advantages of the gas turbine are that it can be used on sites that are entirely devoid of cooling water, it can be designed to start up quickly and accept full load almost immediately, and it gives its highest output and best efficiency under winter conditions when the demand for power is normally greatest.

Experience to date with industrial gas turbines indicates that they will compare favourably in maintenance costs with steam or diesel plant. They can be made small in size and light in weight, thus leading to low transport costs, simple foundations, and the minimum of installation expense.

The gas turbine shows promise of evolving into a robust, reliable and long-lived prime mover, capable of making efficient use of the lowest grades of solid, liquid and gaseous fuels, many of which are now thrown away or run to waste.

It is estimated that in this country alone 2,000,000 tons per year of virtually waste colliery products are lost that could be used in suitable coal-burning gas turbines for generating power at the pithead.

Overseas, the coal-burning gas turbine, needing neither feed-water nor cooling water, may make a contribution to the power industry in countries such as South Africa, Australia and Pakistan. Turbines running on natural gas may find many applications in the oil-bearing regions of Canada, South America and in Pakistan and the Middle East generally.

* * *

Utilisation

There is still a great need for more horsepower per worker employed in our factories. We still lag too far behind certain other countries in this respect, notably the U.S.A. and Canada, though it is fair to add that the picture is somewhat distorted by the fact that in those countries there are great electro-chemical and similar industries which, by their nature, require great quantities of electric power, but relatively only a very small number of workers.

Mining.—In recent years the electric winder has developed a marked ascendancy. It is the declared policy of the National Coal Board to electrify all the remaining steam winding plant as speedily as circumstances permit. Present development in winding practice is to use semi-automatic or fully automatic control, giving a high degree of safety, combined with efficiency. The development of d.c. dynamic braking of a.c. winders has rendered possible the use of a.c. winders in many cases where, in the past, d.c. equipment on the Ward Leonard principle would have been necessary. The reduction in the number of machines required results in lower capital cost and maintenance, and in reduced freight charges (an important matter to overseas buyers).

Steel.—The steel industry is a conspicuous example of an enlightened user of the advantages of electricity. The use of electric drives and control for rolling mills has greatly increased the maximum operating speeds and the output per operator, particularly in the rolling of sheet and tinplate. There are several modern mills to-day running at speeds of 4000ft per minute and one of the fastest has a rated top speed of 7000ft per minute. It is likely that as more comes to be known about rolling problems, considerably faster speeds may be achieved.

The slabbing mill at the Abbey Works of the Steel Company of Wales has an electrical rating equal to that of many of the largest American mills, the twin driving motors having a combined rating of nearly 10,000 h.p. at 40 to 80 r.p.m. This mill handles 17-ton ingots at the rate of about one every two minutes, rolling them down to slabs for strip production.

A number of overseas countries have, in recent years, been putting down new steel plants or modernising old ones. One notable example is provided by Spain, where a large new steel works is at the present moment under construction. Much of the equipment is of British manufacture, but it is interesting to note, as an indication of present trends, that a fair proportion of the mechanical and electrical equipment is being made in Spain to British designs and specifications.

Textiles.—The principal materials involved are cotton, wool, synthetic fibres and natural silk. Cotton accounts for no less than 75 per cent of the demand and wool 18 per cent. Although large electrification schemes have recently been completed for a number of mills in Durham, Yorkshire, Lancashire and Northern Ireland, available statistics show that of the total driving power installed in cotton textile factories in the U.K. only about 38 per cent is by electric motors from public supply.

Electrical manufacturers have produced a variety of equipment for increasing speeds of output and for reducing losses through breakages of fibre and other causes. These include such developments as variable-speed spinning motors, smooth acceleration motors and automatic control, to mention only a few.

Rail Transport.—Although Britain built the first railway and the first steam locomotive over a century ago, we have to-day only eighty-one electric and six main line diesel-electric locomotives on our railway system, out of some 19,000 locomotives in service on British Railways. This is in striking contrast to the U.S.A., where 3558 diesel locomotives were built in the year 1951, all of standardised designs, for the U.S.A. internal railway system.

With our national coal consumption rapidly rising and output steady, or tending to decline, every possible means of conserving our coal resources ought to be employed. Electrification of the railway system in the United Kingdom, or a large part of it, would save several million tons of best-quality coal every year. On the basis of the figures in the Cock Report on Railway Electrification, it would appear that roughly half the lines in this country could be electrified economically. There are many other lines which could be worked more economically with diesel traction than with steam.

What is required is a very bold approach to the very large-scale capital expenditure inevitably involved. It is encouraging to see that British Railways are making a definite move. Their programme is, however, very modest in view of the magnitude of the system.

Comparisons made between diesel-electric and steam locomotives do not always do proper justice to the former. It has been stated that the cost of the diesel-electric is four times that of the equivalent steam locomotive, but this is certainly an exaggeration. Again, in regard to fuel consumption, while there may be little difference between the two in fuel cost on comparable test runs, allowance must be made for the elimination of standby losses in the case of the diesel, and for its much higher rate of availability.

The Domestic Load.—One of the most significant features in the post-war development of the electrical industry has been the rapid growth in the manufacture of electrical appliances for the home. In five years the output of household refrigerators in this country has reached the total of £60,000,000, of which 63 per cent was exported. During the same period, British factories produced over 2,600,000 washing machines, of which 47 per cent were exported. Electric cooker production reached 1,250,000, of which 17 per cent was sent abroad, the remainder being required for use in this country, mainly in connection with new housing programmes.

Nevertheless, only 18 per cent of the wired homes in the United Kingdom own an electric cooker, only 12 per cent own an electric washing machine, and no more than 7 per cent own a refrigerator. Compare this with the figures for the United States, where 90 per cent of the homes have a refrigerator, 79 per cent use washing machines, and 26 per cent electric cookers.

The increasing contribution which the rural load can make to the home market must not be overlooked. The rural electrification policy of the British Electricity Authority and the Area Electricity Boards involves an estimated expenditure of about £130 million over the next ten years. Many country dwellers do, of course, already make full use of electricity, but as the policy referred to involves connecting up a further 60,000 farms and over 250,000 houses, during the first half of the ten-year programme, there are very great opportunities here for the electrical engineering industry to grasp, in bringing improved amenities and greater efficiency to our agricultural communities.

New Materials

Great expectations are held for the future use of titanium, on account of its lightness, its great strength, and the corrosion resistance of its alloys. Though it is the eighth most common element in the earth's crust, it is difficult to produce the pure metal economically due to its affinity for oxygen. It is important that these problems be solved so that applications to rotating machinery can proceed.

The latest improvement of magnetic materials for transformers and other electrical apparatus is the development of cold rolled oriented silicon iron. This material allows a more efficient use of the magnetic properties than the common hot rolled sheet, leading to considerable savings in weight and space for equivalent output.

It is only possible to refer in passing to such developments as the increasing use of aluminium in place of copper for conductors, and the use of toughened glass in place of ceramic insulators in certain applications ; also to the development of silicone varnishes, which permit higher running temperatures for machines, again making for greater efficiency and reduction in weight and bulk.

In the last few years, much has been heard about discoveries in the field of semi-conductors, especially germanium and silicon, whilst the first application of these materials seemed to be for communication purposes, it soon became clear that they could play a big role in the power field, and that within foreseeable time they might completely change our present means of rectification of alternating current.

* * *

Atomic Energy

From every point of view, it is of the utmost importance for this country to place itself well in the forefront in the development of equipment for the production of commercial power from atomic piles. It is important because of our present degree of dependence on one type of fuel —coal—and the precarious position (already referred to) resulting from increased consumption and declining production of that fuel. It is important, too, because exports of plant for power production from atomic fuels may be a very significant factor in world trade in years to come, and we must put ourselves in a fully competitive position.

The electrical engineering profession and industry have to master a new technique. We must learn to use and handle new materials such as liquid sodium and heavy water, as well as the copper and iron with which we are familiar, and we must learn to think of neutron economy as much as of power factor.

The use of fissionable materials as fuel makes it possible to locate power stations in regions where there is little water, and no adequate supply of traditional fuels. This may bring about a transformation in the industrial pattern of the world.

Western Automatic Computer of the National Bureau of Standards

(*By Our American Correspondent*)

The National Bureau of Standards' Western Automatic Computer ("SWAC") has been designed and built at the Institute for Numerical Analysis of the N.B.S. in Los Angeles under the sponsorship of the Wright Air Development Centre. It is now being operated twenty-four hours a day, five days a week, to solve a wide range of complex problems in physics, engineering, mathematics, statistics and meteorology. It is the first high-speed electronic computer in the United States to be equipped with the very fast Williams cathode-ray-tube memory and it has a magnetic drum auxiliary memory. It operates at a rate of 16,000 *additions or* 2600 *multiplications per second.*

THE Western Automatic Computer of the National Bureau of Standards at the Institute for Numerical Analysis in Los Angeles is a high-speed digital computer which has been used, so far, principally to solve aircraft design problems originating with the U.S. Air Force and its contractors, other problems in the fields of science and engineering submitted by Government agencies, and mathematical problems arising in connection with the work of the N.B.S. on computation methods and computing machine development. The high speed of the machine results from its Williams tube memory* and its parallel mode of operation. The memory unit consists of a bank of c.r. tubes which store information as bright spots of charge. The unit is operated in parallel, i.e. all the digits of a number are transferred in or out of the memory simultaneously, thus greatly reducing the time required for the transfer of information. In machines employing the serial mode of operation, such as those using acoustic delay line memories, numbers and instructions are represented by trains of electrical pulses, while in the present computer, parallel circuits transfer numbers and instructions almost instantly, within the time of a single electrical pulse, or about one-tenth of a microsecond. Furthermore, arithmetic operations are also carried out in parallel, with a consequent increase in speed of computation. In its parallel method of operation, "SWAC" differs from "SEAC," the National Bureau of Standards Eastern Automatic Computer, a serial machine constructed by the N.B.S. at its Washington laboratories, which was described in THE ENGINEER, Feb. 16, 1951. Recently the scope and complexity of the problems which the machine can handle have been greatly extended through the installation and successful operation of a magnetic drum auxiliary memory. Based on the principle of the magnetic-tape recorder, the new memory holds sixteen times as much mathematical information as the c.r. tube memory, with which it will be used to increase the overall memory capacity of the machine. The magnetic drum will also act as a store-house for a library of numerical methods or routines of instructions which, when obeyed by the machine, can facilitate the solution of a large class of problems.

Design of Computer

"SWAC" is automatically sequenced, i.e. it automatically performs all of the logical and arithmetical operations required to solve a particular problem once it is supplied with coded instructions and numerical data. The computer stores in its high-speed memory not only the numbers involved in the computation but also the instructions necessary to perform the computation. This makes it possible for the calculator to use fully the speed of the Williams tube memory, doing complete arithmetic operations in a few microseconds. The computer proper is housed in a single console approximately 12ft wide, 5ft deep and 8ft high, which is shown in Fig. 1. It consists of three major parts : an arithmetic unit, a memory unit and a control unit. Furthermore, there are four auxiliary parts : the magnetic drum memory, the input and output units, the operating console and the power supply.

The arithmetic unit performs the arithmetical operations of addition, subtraction and both rounded-off and exact multiplication. It also performs the logical operations of "comparison" and "extract." Comparison involves changing the course of the computation depending on the relative sizes of two numbers. "Extract" divides numbers up into parts which the computer can handle in different ways. The arithmetic unit receives information from the memory in the form of numbers to be operated upon and instructions as to the nature of the operation. Having acted upon such instructions and completed the operation, the arithmetic unit returns the answer to the memory. The memory feeds its information to the arithmetic unit in accordance with instructions it receives from the control unit. The control unit consists of electronic circuits which control the operations of the computer proper. This unit takes information from the input unit, directs it to the memory, tells the memory when to send information to the arithmetic unit, tells the arithmetic unit when and where to return answers to the memory, and controls the feeding out of completed solutions to the output unit. The computer uses both a punched-card input-output system and a paper-tape system. For card input the coded problem is punched on a standard tabulating machine card and the answer is received in the same way. In the paper-tape input-output system a coded problem punched in paper tape is fed into the machine and answers are automatically given in typed form by an electric typewriter, which may be seen in the right-hand foreground of Fig. 1. The operating console is an office desk with specially built panels mounted on its top surface and permits the human operator to control the operations of the machine and to watch the machine as it operates. The console is provided with control switches and neon lights which indicate what is taking place inside the machine. Oscilloscope screens make it possible for the operator to view the memory pattern of any given unit of the Williams tube memory. The machine is supplied with electrical power, at closely regulated voltage, by means of a motor generator set and auxiliary equipment that is largely electronic in nature. The computer is thus isolated from line voltage fluctuations which might affect its operation. In operation the consumption is about 30kW.

Fig. 1—The N.B.S. Western Automatic Computer

Williams Tube Memory

The Williams tube memory consists of a bank of thiry-seven c.r. tubes, each of which can store 256 digits on its face in a matrix pattern of dots and dashes. Figs. 2 and 3 show, respectively, one of the thirty-seven c.r. tubes and the memory pattern of dots and dashes. The dots represent "0," while the dashes represent "1." As "SWAC" is a binary machine, all decimal numbers and instructions are fed into it in a code which utilises only the digits 0 and 1. The number of digits that can be stored on the face of one c.r. tube determines the number of words which can be stored in the memory. Thus, the *n*th c.r. tube stores the *n*th digit of each word, and a given word has one digit stored in the same relative position in each of the tubes. This makes it possible to position all of the electron beams at a given location, or "address," in the memory and, hence, to transfer all of the digits of a word simultaneously. As a result, the time required to transfer a word to or from the memory is only 16 microseconds.

To produce either a dot or a dash at a given spot on the face of a Williams tube unit, the electron beam is turned on to produce a spot on the screen. If the beam is left on only long enough to establish equilibrium and is then turned off, a dot is produced. If the beam is left on longer and is deflected from the dot position by the superposition of a small saw-tooth voltage on the positioning voltages, a dash is produced. The dots and dashes are read off by an amplifier, which picks up the signal from the tube screen, amplifies and reshapes it, and causes the electron beam inside the tube to place a signal back on the face of the tube. Unless this means of storage is continually renewed or regenerated, the original charge pattern tends to disappear over a period of time as the charged spots gradually collect stray electrons. Thus, to provide continuous storage, an electron beam is made to inspect successively each point of charge and to

* See *Proc. Inst. Elec. Eng.*, 100 (1953), pages 523, 543.

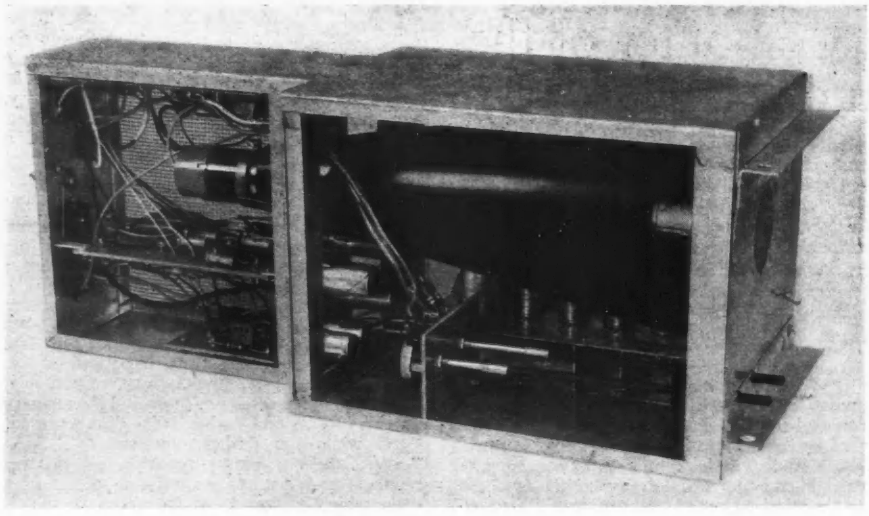


Fig. 2—Williams tube memory unit

energise electronic circuits which, when necessary, restore the charge to its initial value. The regeneration process takes place during short intervals which alternate with the reading-in or reading-out of information in the memory. In this renewal process the machine spends only 8 microseconds on each point of charge on the face of the tube, and complete regeneration occurs 250 times a second. Such a continuous regeneration process makes it possible to store information indefinitely. A crystal-controlled oscillator regulates both the rate of regeneration of the memory and the operations of the arithmetic unit.

Magnetic Drum Memory

While the c.r. tube memory delivers information at a very rapid rate, its capacity is limited by the number of digits that can be stored on the face of a single c.r. tube. To provide greater flexibility and computing power, a magnetic drum external memory has recently been developed and installed by the Bureau. With the drum memory, many complicated problems can be handled by transmitting information out of the computer for storage and then feeding the information back into the computer at a later stage of the problem. The memory unit comprises a revolving metal drum, illustrated in Fig. 4, which retains numbers and instructions on its surface in the form of magnetic pulses similar to those used in tape recording. At intervals, blocks of magnetic pulses are removed from the drum by a magnetic head and are taken into the computer to be transformed electronically into spots of charge in the Williams tube memory, where they remain until called for by the control unit. The computer stores and processes information in units called words, each word consisting of thirty-seven binary digits, the equivalent of eleven decimal digits. The magnetic drum has a capacity of 4096 words of thirty-seven binary digits each, in contrast with the 256-word capacity of the c.r. tube memory. The instruction routines stored on the drum will handle, *inter alia*, the conversion of information from a decimal representation into the binary representation used by the machine, as well as the final conversion back to decimal form when it is required to print out results.

In the construction of the magnetic drum, primary consideration was given to simplicity of design and highest efficiency in the transfer of information between it and the c.r. tube memory. A drum memory ordinarily has a much larger capacity than a Williams tube memory, but access to a drum memory is generally slow. In particular, if information is required from some specific position on the drum, the computer may have to wait up to a maximum of one drum revolution before receiving any information. However, in the magnetic drum memory developed for "SWAC," the access time has been shortened in two ways: (1) numbers are transferred in sizeable blocks from the magnetic drum memory to the c.r. tube memory, thus minimising the total number of times the drum memory must be consulted; (2) the numbers in each of these blocks are stored sequentially around the circumference of the drum so that one block forms a band or channel completely encircling the drum. When a transfer to or from the drum memory is made, the whole channel is handled at one time. Transfer of information starts immediately after the proper channel has been selected and continues for exactly one drum revolution, thus eliminating all waiting time. In this way the access time per word has been reduced to 500 microseconds, equivalent to about one-thirtieth of the normal access time of a magnetic drum memory.

Information is stored serially on the drum in forty-binary-digit words. The first thirty-six digits represent numerical information, the thirty-seventh digit gives the algebraic sign, while the remaining three digit positions are empty. Thirty-two words are stored in each channel and constitute a basic transfer block. As the drum rotates at 3600 r.p.m., thirty-two words are transferred in approximately 0·017 second. The drum contains 128 information channels as well as four timing channels. The timing channels feed a timing generator, which generates a pulse for each digit space, a pulse for each word space, and a reference pulse for each revolution of the drum. The pulses marking each word space go to an "address" counter, which counts from 0 up to and including 31. This counter continuously keeps track of the word spaces as they pass under the magnetic read-write heads. The reference pulse is used initially to synchronise this counter with the drum.

The c.r. tube memory operates in parallel with the serial magnetic drum memory, and the two units are not in synchronism. Direct communication between the memories is therefore not possible. Information from the drum must first be played back into a vacuum valve shifting register and then transferred in parallel to the c.r. tube memory. Each digit takes 13 microseconds to play back, so that the three empty digit spaces in each word give rise to a total delay of 39 microseconds between words. This delay is more than adequate for transferring a number from the register to the c.r. tube memory and for clearing the register to receive new information. The entire drum memory system consists of less than a dozen different basic single-valve plug-in units which were developed to obtain a high degree of stability under various conditions of loading and ageing. In addition to the drum memory, present plans call for the installation of a slow-speed auxiliary memory consisting of a magnetic-tape unit. It will have a much larger capacity than the other two memories, holding approximately 4,000,000 binary digits, but its average access time will be quite long—about three and a half minutes.

Operating Experience

"SWAC" contains about 2600 vacuum valves and 3700 crystal diodes. The average valve life has been found to lie between 8000 and 10,000 hours. To date, very few valves have been lost because of heater failure, and the largest percentage of failures have resulted from low emission and intermittent shorts. All electronic components in the computer proper are mounted on removable plug-in chassis, so that faulty operation can usually be corrected by replacing a bad chassis with a good spare unit. The faulty chassis can then be repaired in the laboratory without loss of computer time. The majority of the plug-in chassis contain an average of ten valves each; however, the magnetic drum circuits are built up of much smaller units, usually consisting of a single valve. One of the difficulties encountered with the c.r. tube memory has been "spill-over," or redistribution of charge, which limits the number of times the spots adjacent to a particular spot may be read before the spot in question must be regenerated. To mitigate this difficulty, circuits have been installed which eliminate most of the drift in the patterns on the face of the tubes, and a substantial improvement in operating time has resulted. Other improvements have been achieved by rebuilding certain parts of the circuitry which have been found to require much maintenance. A substantial improvement in operating time occurred when an air-conditioning unit was installed to maintain the incoming air in the ventilation system at a constant temperature. This minimised the temperature cycling of the crystal

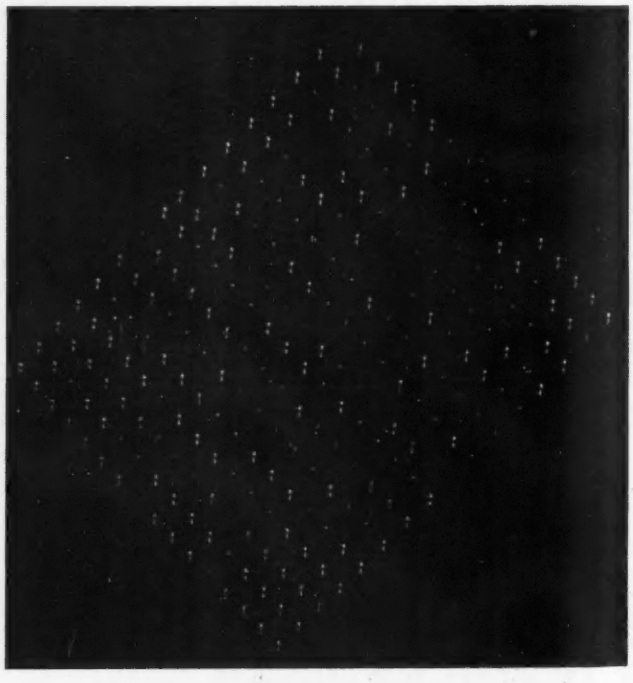


Fig. 3—Williams tube memory pattern

diodes and substantially decreased the number of diode failures. The general operating efficiency of the computer has also been increased by the addition of a loudspeaker and a buffer tube with a plug-in arrangement allowing the operator to "listen" to any of the commands in a problem. For example, an alternate succession of add and subtract commands produces a note having a frequency of 8 kc/s. Recently, by the addition of one valve and a few crystals, a converting output command was obtained. This command, which is effective only with the output typewriter and the tape punch, converts fractional binary numbers to octal numbers, decimal numbers, or numbers of any other base up to sixteen.

Problems Solved

More than fifty problems were handled by the computer in the past year, ranging from minutes to hundreds of hours in running time. During this period the punched-card input-output

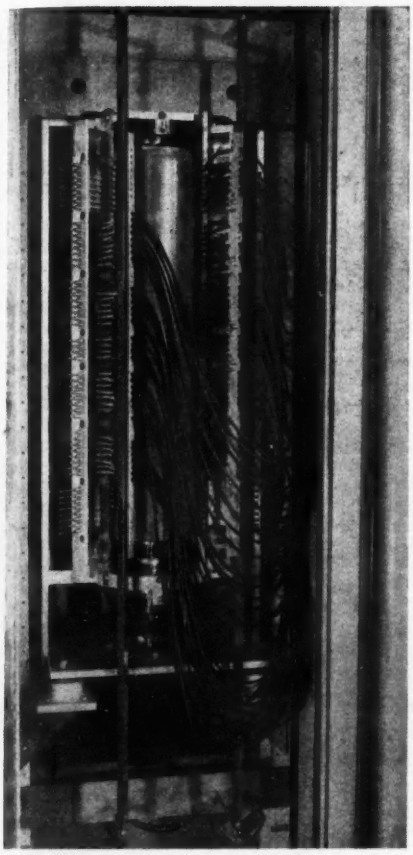


Fig. 4—Magnetic drum memory unit

system was operative, but the magnetic drum had not yet been installed. Problems in the fields of least squares, reduction of data, heat transfer, stress analysis, and many other physical phenomena can be described by systems of linear equations. However, most of the methods now in common use for solving such equations are variations of the elimination method developed by Gauss. These methods all tend to yield answers of low significance when the matrix of the coefficients is almost unity. Using "SWAC" for extensive numerical trials, members of the staff of the Bureau have recently developed a new approach, known as the conjugate gradient method, which appears to be well suited for the solution of problems arising in applied physics and engineering. "SWAC" has now solved many systems of equations of the order of 10 to 15. Codes have been prepared for the solution of systems of any order up to 45, but no system of that high order has as yet been solved. However, the characteristic values and their associated vectors have been found to nine significant decimal digits for a 45th order system, as well as for systems of the order of 10 to 20.

In the field of differential equations, a large amount of computing time has been devoted to the study of associated Legendre functions, $(p_n^m x)$, which are important in the mathematical analysis of radiation fields from wireless aerials. The specific problem was the determination of the non-integral values of the order (n), which, for fixed values of degree (m) and argument (x), would make the value of the function zero. For each combination of m and x an infinite set of discrete values of n will satisfy the requirements. The computer found the first thirty values of n corresponding to one value of x and three values of m.

With the aid of "SWAC" the National Bureau of Standards has carried on research in the application of the so-called "Monte Carlo" method to the solution of complicated differential equations and of previously unsolved statistical problems in nuclear physics. The Monte Carlo method, which was developed by J. von Neumann, of the Institute for Advanced Study at Princeton University, and S. Ulam, of the Los Alamos Scientific Laboratory, University of California, is a new mathematical technique which solves a physical or mathematical problem by creating an artificial statistical model of the physical or mathematical process involved. It applies the techniques that are used in analysing games of chance to the analysis of physical problems where the events are random and are governed by the laws of probability. Large-scale computers such as "SWAC" provide an excellent means for the solution of problems of this kind because they are able to create conditions which imitate the statistical behaviour of the given problem. Thus, the randomness of the event can be taken care of by putting into the extended memory of the machine a set of random numbers which are first tested for their random quality. The computer has been used to compile large groups of random digits, to explore their statistical behaviour, and to investigate their ability to solve partial differential equations by random walk processes.

Problems in the evaluation of definite integrals have arisen from studies in probability and statistics. One such problem, the computation of a table of survival probabilities for biological experiments, required the evaluation of 21,500 double integrals with each variable ranging from plus to minus infinity. This table was computed in 177 hours. A second table, for biological experiments in which the exact level of a radiation dose is unknown, required the evaluation of 7500 single integrals, involving an infinite lower limit and a finite upper limit. Many applied problems have dealt with the reduction of large blocks of data. A representative study concerned the large-scale circulation patterns in the atmosphere of the earth. Some 750,000 pieces of data, each five decimal digits in length, were processed to yield about the same number of answers, the computer spending 325 hours on this problem. Several combinatorial problems have also been tackled. In some of these, "SWAC" has searched exhaustively through all possible combinations of the variables. One such problem was that of finding "difference sets," i.e. a set of n numbers such that all $n(n-1)$ non-zero differences give distinct remainders when divided by n^3-n-1. Another problem, involving permutations, dealt with the optimal assignment of duties in an organisation. The computer has proved to be an effective tool for the analysis of Fourier synthesis of X-ray diffraction patterns of crystals. Such analyses, which are at present being carried on by members of the Chemistry Department of the University of California at Los Angeles, supply data leading to the determination of the arrangement of molecules inside the crystals.

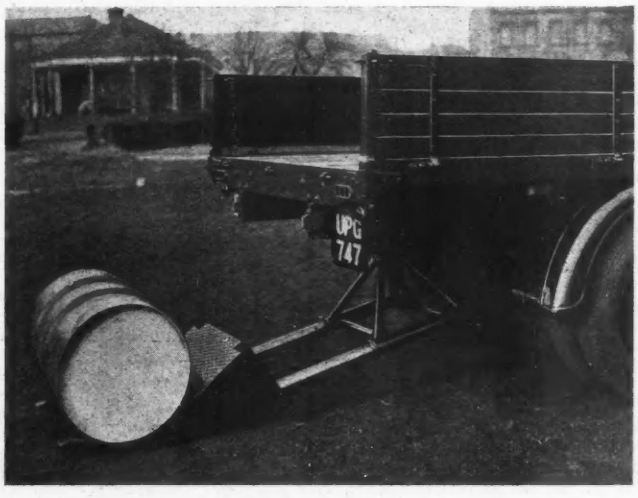
In the field of pure mathematics, "SWAC" has been used to study the primality of the Mersenne numbers, i.e., numbers of the form 2^p-1, where p is a prime. These numbers, when prime, are related to the "perfect numbers" of the Greeks, which are the sum of all their integral divisors excluding themselves. The present list of values of p which yield prime numbers is as follows: 2, 3, 5, 7, 13, 17, 19, 31, 61, 89, 107, 521, 607, 1279, 2203 and 2281. The last five values were added to the list by the computer as a result of the systematic testing of all prime numbers up to 2297. Mathematical research directed toward the more effective utilisation of electronic digital computers is continuing at the Institute for Numerical Analysis of the N.B.S. Further progress in this programme is expected to increase materially the scope of the problems which "SWAC" and other high-speed computers can handle and should also make possible additional savings in actual computing time.

Lorry Loader

A LORRY loading device now being made by Felco Hoists, Ltd., 29, Cromwell Road, London, S.W.7, has been introduced to facilitate the work of loading and unloading vehicles, making them independent of additional labour or mechanical facilities when transporting heavy goods such as oil drums, crates, sacks, &c. The device is hydraulically operated through a pump driven from the vehicle engine power take-off, and it can readily be fitted to most makes of lorry. A typical installation can be seen in operation in the photograph we reproduce below.

The loader consists essentially of a chequer plate platform mounted at the end of a pair of tubular support arms which are pivoted on brackets at the rear of the lorry frame. A powerful hydraulic jack is coupled to the rear of the support arm assembly and is supplied with pressure fluid by a high-pressure pump driven by the engine power take-off. Fork arms pivoted on the back of the platform are designed to lie flat on the ground whilst the platform is lowered and to rise automatically to provide a back support for the load before the upwards movement of the platform begins. In its uppermost position the platform is level with the lorry deck. Movements of the platform are controlled by a lever placed in such a position at the side of the lorry that it can be operated by a man standing on the ground or on the lorry deck.

The device handles loads weighing up to 15 cwt and a release valve prevents damage to the mechanism in the event of overloading. When the loader is not in use its platform is folded back and its telescopic tubular arms are retracted so that the complete device can be stowed out of the way and locked in position under the body of the vehicle.



Lorry fitted with loading device of 15 cwt capacity. The loader is operated by hydraulic jack supplied by a pump driven from the engine power take-off

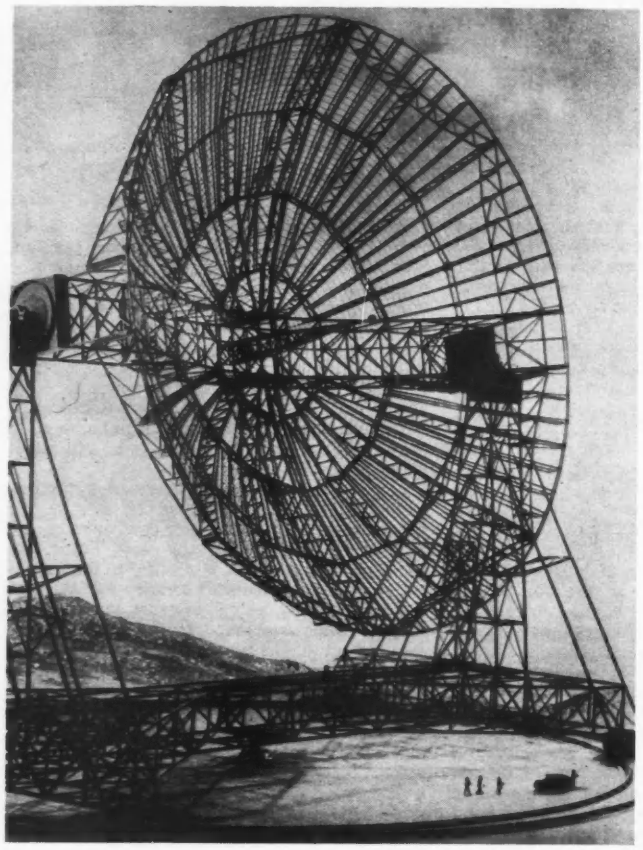
Radio Telescope at Jodrell Bank

ERECTION of the radio telescope for the University of Manchester at Jodrell Bank has now begun. The great size of the structure can be realised from the model illustrated below, the bowl having a diameter of 250ft and the height to the upper rim when the bowl is tilted being 300ft.

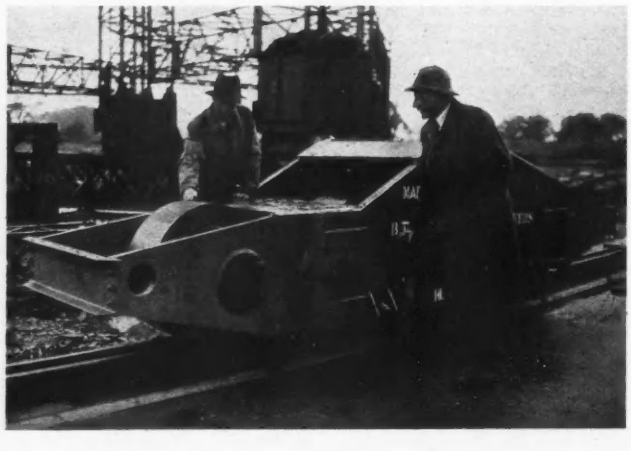
As is well known, Professor A. C. B. Lovell, who is the Professor of Radio Astronomy at Manchester University, has been applying the radio and radar techniques developed during the war to the study of radio emissions from interstellar space, and the research programme was discussed in an article in THE ENGINEER, May 9, 1952. Reference was made at that time to the discovery in 1951 of a spectral line emission from the hydrogen gas in the Milky Way on a wavelength of 21cm, this being the only line frequency to be emitted in the radio wave region.

By observation of the "Döppler shift" in this frequency it is possible to establish the speed of recession of the earth from the hydrogen gas clouds in the remote part of the Milky Way system. This spring some of the workers at Jodrell Bank succeeded in combining the 21cm technique with their studies of the emission from the radio stars and have managed to obtain an outstanding measurement, namely, that of the distance of the so-called radio stars. Hence, although the long wavelength of the radio emission presents very great difficulties, the workers in this field have already succeeded in measuring the position, size and distance of some of these stars.

The new steerable telescope will be the only one of its kind in the world and it is expected to cost about £500,000. Much of it has now been fabricated and its erection is expected to be completed towards the end of 1955. The foundations, which are already nearing completion, have been taken down to the Keuper marl at a depth of about 90ft, and they include 4000 tons of concrete and 700 tons of steel. The structure itself is of considerable interest as it was essential that deflections were kept within particularly small limits, and its design and erection are expected to be the subject of a paper at a later date. As can be seen from the model, the telescope will rotate on twelve bogies weighing about 20 tons each, around a track 310ft diameter. One bogie is shown in our second illustration, which also shows Professor Lovell standing in the foreground, and Mr. H. C. Husband, of Husband and Co., Ltd., the consultants for the project. In laying the track its rails were kept level to $\frac{1}{16}$in. The bowl is secured to a horizontal girder mounted upon two fabricated towers, 185ft high. The girder is rotated for bowl elevation by means of racks, their setting being to $^{1}/_{32}$in. The bowl is rotated by four electric motors, two in each tower, and its tracking movements are controlled electronically. Together, the bowl and cross girder weigh 600 tons, of which the 1in copper mesh forming the bowl contributes 30 tons. The depth of the bowl and the height of the aerial tower within it is 62½ft. Altogether, the total weight carried on the bogies is about 1500 tons, most of which is taken on four bogies disposed at the end of the cross girder. The others act as outriggers under wind loading.



A scale model of the radio telescope at Jodrell Bank. The height with the bowl in this position is 310ft, and the diameter of the runway is 300ft.



One of the twelve bogies on which the telescope will rotate

As a protection against lightning the track is earthed in such a way that at least one bogie is always over an earth.

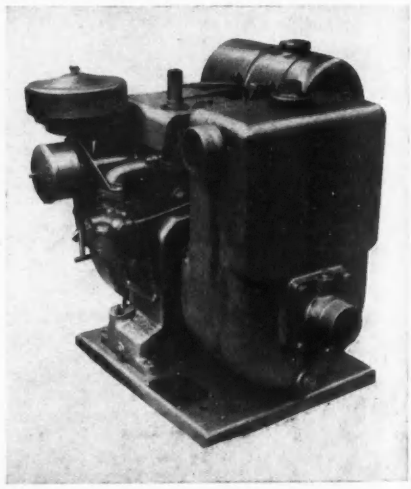
Lifts and stairs have been provided in the towers. Laboratories will be situated at the top of the towers and there is to be a laboratory swinging with the bowl. There will be catwalks on the cross girder and in the aerial tower, which will be for use only when the bowl is pointing upwards. Electrical power is provided from the station's own power-house, one reason for this arrangement being to avoid the undesirable effects on reception of grid and other electric cables near to the telescope.

High winds are expected to present the chief engineering problem during construction. Comprehensive wind tunnel experiments on the effect of wind on the mesh of the bowl were carried out in the Aerodynamics Division of the National Physical Laboratory. Once built the instrument will be strong and will stand up to wind stresses, but when only half completed the telescope is vulnerable and special precautions will have to be taken.

Small Self-Priming Centrifugal Pumps

NEW production lines have been laid down at the Coalville works of Pegson, Ltd., for the manufacture of the firm's smaller sizes of engine-driven, self-priming centrifugal pumps from 1½in to 3in, which are widely used in industry and agriculture. These pumps are made in a range of sizes and are available with a number of different types of engine and electric motor drives.

The firm recently introduced an improved design of its 1½in and 2in centrifugal pumps, and one of the 2in models can be seen in the illustration below. The pump casing now fitted gives a direct suction flow into the eye of the impeller which has also been redesigned to make possible higher flows and heads than in the older models. This cast iron casing incorporates a clack valve



2in engine-driven, self-priming centrifugal pump

to prevent the loss of priming liquid and a special turbine renders the pump self-cleaning. A five-vane, open trash impeller of cast iron is used when handling grit and solids up to ½in, and is mounted on an extension of the engine crankshaft. The "multi-point" priming used in earlier designs has been retained, and holes at the tip of each diffuser vane return the primary liquid to the tips of the impeller vanes during the priming period.

The discharge branch is an integral part of the pump casing, whilst the suction branch has been made detachable to give access to the pump interior for inspection.

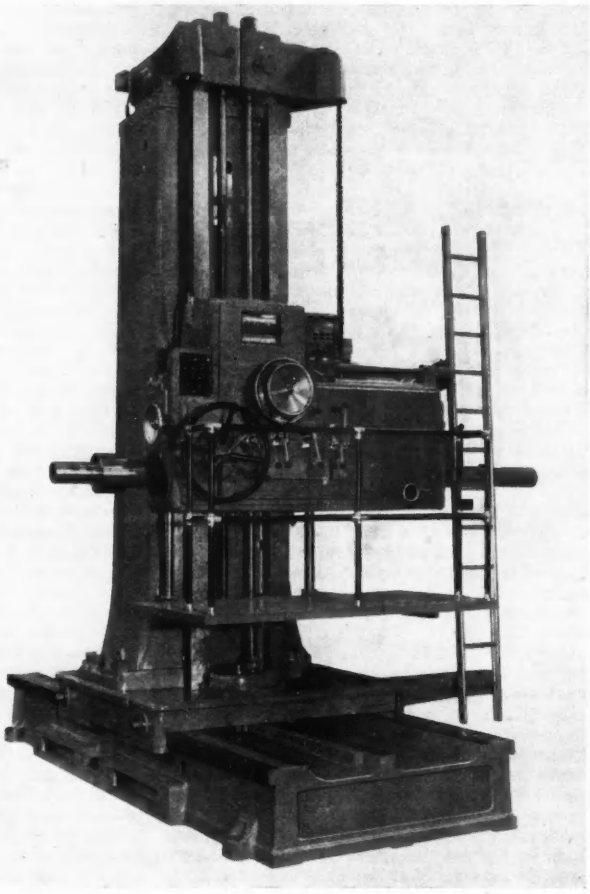
The pump is mounted as a complete unit with

the engine on a pressed steel baseplate and is driven at 2600 r.p.m. It has a maximum suction lift of 25ft on cold fresh water, whilst its maximum head is about 68ft and maximum delivery 200 gallons per minute.

Horizontal Drilling, Boring and Milling Machine

A NEW 4in spindle horizontal drilling, boring and milling machine, now being made by Kitchen and Wade, Ltd., of Arundel Street, Halifax, is illustrated herewith. The rigid box section column of this machine is mounted on the slideways of a 5ft wide bed-plate provided with facings to accommodate either a slotted base-plate, box table or rotary table to suit the class of work to be machined. The column has a horizontal traverse of 12ft along the bed-plate and a 5 h.p. motor at the top of the column driving through gearing, vertical shaft and a pinion and rack provides rapid traverse. The saddle is balanced and has a vertical traverse of 8ft on the column slideways, rapid motion being provided by a second 5 h.p. motor at the top of the column. These two traverse motions can be engaged simultaneously or independently when setting the machine.

The spindle has a maximum traverse of 3ft and its nose end is bored No. 6 Morse taper. The feed rack is cut in a steel sleeve which supports the spindle. A 10 h.p. motor on the saddle drives the spindle through gears providing thirty-six speeds, which are available in three alternative ranges from 4 to 480, 5 to 600, or 2½ to 300 r.p.m. Eighteen rates of power feed ranging from 0·006in to 0·166in per revolution of the spindle are available for drilling and boring work. Similar feeds are available for vertical movements of the saddle and horizontal movement of the column for milling operations, and these milling feeds can be operated simultaneously when required. Fine hand motion is available for all saddle, spindle and column movements. Effective locking arrangements are provided for the saddle and column, and for the spindle, when milling. Electric limit switches are fitted for the extreme positions of traverse, and the spindle feeds, milling feeds and rapid traverses are interlocked either electrically or mechanically.



4in spindle, horizontal drilling, boring and milling machine with thirty-six spindle speeds and eighteen rates of power feed to the saddle, spindle and column

Pressure lubrication to the saddle mechanism is provided by a built-in oil pump, and an illuminated panel at the top of the saddle enables the oil flow to be observed. Starting of the main or column traverse motor brings into operation the automatic lubricating system for the bed slideways. The various motors are controlled from a built-in push-button panel at the left-hand end of the saddle.

LLOYD'S REGISTER OF SHIPPING.—We are informed that Sir Ronald Garrett has been re-elected chairman of Lloyd's Register of Shipping and that Sir Guy Ropner has been re-elected deputy chairman. Mr. J. E. Green was elected deputy chairman and treasurer in succession to Mr. A. E. M. Gale, and Mr. W. J. Ferguson is to combine his duties as chief executive with those of secretary.

Verein Deutscher Ingenieure Meetings in Mannheim

THE eighty-fourth annual general meeting of the Verein Deutscher Ingenieure was held in Mannheim, from Friday, May 28th, till Tuesday, June 1st. The theme chosen for this year was "The Conversion of Matter and Energy."

Mannheim and Ludwigshafen stand at the confluence of the two rivers, the Rhine and the Nackar, and within a radius of 25km there is a population of about 1,000,000 people, most of whom are actively engaged in the chemical, engineering and allied industries. The recent meeting was the third to be held in Mannheim by the V.D.I. since its foundation in 1856, the first having taken place in September, 1884, and the second in May, 1927. This year more than 2000 members and guests took part in the meetings, and they were given a cordial welcome by the Nordbadish-Pfälzischen Branch Verein. The meetings were held in the fine buildings of the Rosengarten with its Musensaal and Mozartsaal, while additional accommodation was found in the adjacent America House, and the Art Gallery.

On Friday afternoon, May 28th, two lectures were arranged by the Nordbadish-Pfälzischen Verein in collaboration with the Chambers of Commerce of Mannheim and Ludwigshafen. They were given by Professor Dr. Schuster of Cologne, Dir. Dr. K. Pentzlin, of Hanover, and dealt with the development of technical knowledge and science and its relationship with commercial and economic progress. A strong plea was made by both speakers for greater harmony between economic progress and technical science.

During the evening Director E. Kothe, of the V.D.I., Düsseldorf, opened the exhibition "From the Work of the V.D.I.," which had been arranged in the entrance hall to the Rosengarten. It was designed by Ing. H. Bilberger, Director of the Düsseldorf Commercial Museum, and showed the organisation of the V.D.I., its field of activity and the work of its many committees. The relation of the Verein, with its thirty-seven local branches and its membership of more than 28,000 persons, was also described, as were its national and international relations with scientific bodies and institutions. The work it has done in connection with German patents was illustrated and examples were shown of its many publications of books and journals. An informal dinner completed the evening.

On Saturday morning, May 29th, the main opening meeting was held in the Musensaal. The curator of the V.D.I., Professor Dr.-Ing. E. Siebel, introduced the theme chosen for this year's meetings and spoke of the many advances made in the chemical industry in recent years in the production of synthetic substances. He then called upon Dr.-Ing. Dipl.-Ing. Fr. Jähne, of Munich, to give the first main lecture. Dr. Jähne recalled that in the early days the chemical industry was concerned in the building up of new substances by simple or complicated processes, which was later followed by the production of dyes and pharmaceutical drugs. Then the use of catalysts was discovered and the processes of cracking developed with the introduction of artificial rubber and other useful substances. It was very necessary, he said, that research, invention and engineering should continue to work together. The second main lecture was then given by Professor Dr. K. Wirtz, of the Max Planck Institute for Physics, Göttingen. His subject was the present and future position of the production of mechanical power from nuclear reactors. He described the physical and technical problems involved in the design and operation of different reactors, emphasising the importance of training young engineers for this highly specialised work.

After these two main lectures the technical sessions were begun. In the section on production engineering, Dir. Dr.-Ing. O. Koehn, of Frankfort, spoke on the need for sharing knowledge of production problems in carrying out the rationalisation of manufacturing processes and the need for consultation both within the factory by all concerned and with outside bodies. Dir. Dipl.-Ing. G. Lindler, of Ulm, spoke on the economy of special machine tools and finishing lines used for the production of the parts for an air-cooled petrol engine. In a third paper, Professor Dr.-Ing. Opitz, of Aachen, gave some interesting information on the use of special steel tools with hard tips, for the cutting of building steels. He gave examples of cutting angles, cutting speeds and feeds, for good production and long tool life. In the section on heating and ventilation, Dir. Dr.-Ing. Krüpe, of Mannheim, described the construction and working of the new high-duty "Strebel" automatic heating boiler, while Obering K. Rath, of Wetzlar, gave particulars of several new high-capacity boilers for central heating. Oberreg. Baurat Dr.-Ing. E. Jacobi, of Düsseldorf, dealt with the economic use of measuring and regulating devices in heating installations using boilers fired with solid fuels. Last year a new section was established for the technical and daily press, to bring together journalists so as to further the correct presentation of scientific and engineering information. This year two papers were presented, the first by Dr.-Ing. E. Heinrich, of Siemens House, Erlangen, concerned the preparation of press information for the technical and the daily press, the presentation of information about exhibitions and trade fairs, the arrangement of press visits to works and the calling of press conferences. Mr. M. Kluth, of Murmau/Obb, the editor of *Design News*, Detroit, spoke on some of the American methods of educating journalists for the technical and daily press in technical colleges and universities. During Saturday evening, officials of the

V.D.I. visited Kaiserslautern and laid a wreath on the grave of Friedrich Euler, the first President of the V.D.I. In Mannheim a wreath was laid on the grave of Hofrat Dr. Phil. Dr.-Ing. Heinrich Caro, a leader in the chemical industry and one of the V.D.I. founder members. Later, all the members and guests attending the meetings assembled in the Musensaal and the Mozartsaal of the Rosengarten, and were officially welcomed by Dir. Dipl.-Ing. Rudolph Kranz, the president of the Nordbadish-Pfälzischen Branch Verein. There then followed a programme of opera and ballet scenes, presented by the National Theatre, Mannheim, which this year celebrates its 175th year of jubilee.

On Sunday morning, May 30th, the " Festakt " took place in the same hall. The meeting was opened by the playing of Weber's Overture " Euryanthe," after which the president of the V.D.I., Bundesminister a.D. Dr.-Ing. Dipl.-Ing Hans Schuberth, gave an address. In it he made reference to the special theme chosen for the meetings and spoke on the very close connection of Mannheim and district with the rise and development of the chemical industry, along with the ever expanding engineering industry. There then followed the greetings to the V.D.I. brought by government, civic and scientific bodies. The president next called upon Professor Dr.-Ing. K. Wurster to deliver his lecture on " Research as the Foundation of the Chemical Industry." Dr. Wurster reviewed the beginnings and the later developments of the German chemical industry and showed that all along engineers had given advice and help, particularly in the design of plant for special processes and the control of such factors as pressure, temperature and corrosion. There had been close co-operation, he said, between German, French and British scientists in the development and working of new processes, and this had been largely made possible by the excellent training provided in the high schools and the universities. He expressed the hope that in future chemists and engineers would continue to work together and thus enable research to carry on its good work.

Having thanked Dr. Wurster for his lecture, the president, Dr. Schuberth, proceeded with the distribution of V.D.I. honours for 1954. The Grashof Medal was presented to General Director Dr. Otto Meyer of the Maschinenfabrik, Augsburg, Nürnberg, for his work in introducing scientific methods in workshop practice, and honorary membership was conferred on Dr.-Ing. Adolf Heller, of Stuttgart, for his early work in the engineering industry and his activities in the branch Vereins of Augsburg and Württemberg. The V.D.I. Mark of Honour was given to Betriebsdirektor Willy Franzenburg, of Hamburg, for his work in the organisation of the shipbuilding and marine engineering industry, and a similar honour was conferred upon Dr.-Ing. Arthur R. Sadofsky for his work in connection with the Dresden textile industry. The V.D.I. Ring, which is given as an encouragement to the younger men under forty years of age, was presented to Oberingenieur Heinrich Hack, of the Carl Schenck Maschinenfabrik G.m.b.H., Darmstadt, for his work on the design and construction of automatic balancing machines. Another recipient of the ring was Regierungs und Baurat Karl Hipp, of Stuttgart, for his research work. He is now in charge of research and rationalisation at the Landeswerbeamt in Stuttgart. Dr.-Ing. Heinrich Novak of Nürnberg also received the V.D.I. Ring for his work on heat transmission and on new coke oven design. Finally, a V.D.I. Ring was presented to Dr.-Ing. Jacob Wachter, of the Siemens-Schuckert Mülheim Works, for his work on electronic instruments for the measurement of stress and strain under rotation. The Festakt ended by the playing of Beethoven's " Leonora No. 3 " Overture.

On Monday morning, May 31st, the reading and discussion of a series of technical papers was begun, while at the same time a number of half-day visits to works in the near neighbourhood were arranged. In the section devoted to the consideration of problems concerning power and heat and power station operation, several interesting papers were presented. Dir. Dipl.-Ing. W. Ellrich, of Mannheim, dealt with the planning of power stations. Assuming that coal would remain the principal fuel in Germany, he said that further economies were possible with a careful choice of steam temperature, intermediate reheating and the size of the turbine and the generator. Hydrogen cooling would improve generator operation and the boiler efficiency might be increased. Professor Dipl.-Ing. Senger, compared the performance of a condensing unit with one designed for the production of power and heating and said that it was the task of the engineer to find the most economic unit for a given duty. Dir. Dipl.-Ing. H. Mayer, of Mannheim, spoke on possible economies by making the temperature after the last ring of blading almost equal to the cooling water temperature or the air temperature in an air condenser. A paper presented by Dir. Dipl.-Ing. J. Koch, of Heidelberg, dealt with the problems of town and factory heating from steam power stations.

The question of raw materials, particularly steel, was fully discussed in a series of papers, the first of which was presented by Professor Dr.-Ing. H. Wiegand, of Darmstadt. He pointed out that a real understanding of the qualities of a given steel was needed by the designer of a structure and the maker of machine parts. Dr.-Ing H. Holdt gave some particulars of long-period tests carried out on heat-resisting steels. He said that tests of 10,000 hours' duration had revealed that brittleness appeared in some low alloy steels which could be removed by annealing at temperatures between 500 deg. and 550 deg. Cent. Special austenitic steels for high temperature work between 575 deg. and 700 deg. Cent. were also discussed. In a further paper, Obering Dr.-Ing. I. Class dealt with some special steels for the construction of high-pressure vessels used in the chemical industry.

In the section dealing with plant design and technology Dir. Dr.-Ing. E. Mach described the construction of various vessels used in high-pressure chemical plants for reactions with catalysts for heating or cooling, and for the separation of liquids and gases. He also described some of the special fittings and instruments used with such plants. Obering Dipl.-Ing. C. H. Futterer dealt with special machinery, such as gas pumps used in high-pressure processes, and its design and construction. Dr.-Ing. Chr. Alt spoke about optical methods used to ascertain the stresses in certain parts of high-pressure plants and the use of models made from new materials produced by a polyester method which have given good results with optical methods of stress determination.

In the series of papers dealing with automobile engineering, Dir. Dr.-Ing. W. Staniewicz, of Brunswick, reviewed the development of the omnibus for transport in towns and cities, and Dir. A. Maier, of Friedrichshafen, dealt with some factors in the development of the road transport vehicle. He pointed out that both in Germany and abroad it was usual to buy the gearing units for speed control from specialist firms which had developed gearboxes for light, medium and heavy transport lorries. In the future he thought that development would take place in two directions : first, in fine-stage gear drives with direct control through friction couplings, and continuous or semi-continuous stepless speed changes. The higher cost of the stepless drive brought quicker speed changes, quieter running and increased safety.

In the design and construction section a paper was read by Dip.-Ing. Konrad of Ludwigshafen, on the use of constructional elements formed by winding strips of steel around a central core, which are used in high-pressure plants. Obering Dipl.-Ing. F. Götze, of Berlin, dealt with the production of surface qualities in metals and the need for more knowledge of the surface conditions of metals for the use of the designer. In the last paper in this section, Dr.-Ing. G. Köpke, of Oberhausen-Sterkrade, gave a full account of the use of nodular cast iron in Germany for widely differing purposes.

Three papers were presented on measuring instruments. Dr.-Ing. J. Perthen, of Hanover, described the present position of surface measurement and said that there were now a number of measuring instruments which could give quickly an accurate measurement of surface quality, and which had greatly improved the standards of inspection. Professor Dr. U. Graf, of Düsseldorf, spoke on the use of statistical methods in the workshop for inspection purposes and Dr. G. Wagner, of Stuttgart, dealt with the use of control cards in inspection.

Two papers were read on agricultural engineering. Professor Dr.-Ing. W. Knolle, of Heidelberg, spoke on the limits imposed on the designer of agricultural machinery. He said that the construction elements of agricultural machinery were well known ; the problem seemed to be to combine those elements in the most useful way, and to produce machinery at an economic price. Professor Dr. Rheinwald, of Stuttgart-Hohenheim, spoke on the technical problems of the farm.

The half-day visits to works on Monday morning and afternoon covered many industrial interests. They included the works of Heinrich Lanz A.G., Mannheim ; the Mannheim-Luzenberg gasworks, where there is new plant designed for a daily output of 500,000 cubic metres of gas. At the works of Foerstner and Co., Ladenburg/Neckar, fire protection equipment of the dry and wet quenching types was seen in course of manufacture and under test, and there was a visit to Strebelwerk G.m.b.H., of Mannheim, which constructs central heating boilers and plants. A modern oil tank installation was shown by the Esso A.G. at the Mannheim Neckar Point.

At the Daimler-Benz Mannheim works, which were founded in 1883, the modern construction of lorries and motor-buses was seen. There were also visits to the works of Halberg Maschinenbau und Giesseri G.m.b.H. at Ludwigshafen-am-Rhein ; Zellstofffabrik, Waldhof-Mannheim, which produces cellulose, paper and chemicals ; Bopp and Reuter of Mannheim-Waldhof ; and the Oberrheinische Kohlenunion, Bettag Puton.

On Monday evening some 600 members of the party with their ladies left Mannheim on the special Samba-Express, appropriately named the " Sorgen-Brecker," for Wachenheim in the Pfalz, where the vineyards were seen.

Tuesday, June 1st, was devoted to four morning visits and seven whole-day visits. They included the firm of Gebrüder Giulini G.m.b.H., Ludwigshafen ; the Motorenwerke Mannheim A.G. vormals Benz Abt Stationär Motorenbau ; and the Grosskraftwerk Mannheim A.G. at Mannheim-Neckarau, where the Marguerre power station was visited. In this station there is installed a total of 196MW of turbo-generator plant, working with a boiler pressure of 100–110 atm. and a temperature of 485–495 deg. Cent. with desuperheating. In the No. II power station now under construction a new 123MW high pressure turbine is being installed, for a working pressure of 185 atm. and a temperature of 520 deg. Cent. The two new condensing sets each have a designed capacity of 40MW and will be coupled to three-phase alternators and, by transmission gears and fluid couplings, to two 16⅔ cycle alternators for supplying the electric railway system. The 1953 output of the Marguerre station was about 1000 million kWh.

Another visit of special interest to electrical and power station engineers was that which was paid to the Mannheim-Käftertal works of Brown-Boveri and Cie A.G. These works were founded in 1900 to undertake the construction of large steam turbines and generators and turbo-compressors and transformers. There we saw under erection the largest single shaft turbine yet built for 3000 r.p.m. It has an output of 187·5MVA and will be shortly installed in the Weisweiler power station of the Rheinisch-Westfalische Elektricitätswerk, now being built on the edge of the Rhine brown coal district. Another interesting large turbo-generator going through the shops was the 143MVA unit for the Frimmersdorf power station which will be equipped with hydrogen cooling. Other visits were to Badische Analin and Soda Fabrik A.G., Ludwigshafen ; the Daimler-Benz Aktiengesellschaft at Gaggenau ; Kühnle, Kopp and Kausch Aktiengesellschaft ; Klein Schanzlin and Becker and Maschinenbau Aktiengesellschaft Balcke, all at Frankenthal.

There will be, we learn, no special annual meeting next year, but in 1956 the centenary of the Verein Deutscher Ingenieure is to be celebrated at a special meeting which will probably take place in Berlin.

Industrial and Labour Notes

Overseas Trade

The Board of Trade's detailed report on the country's overseas trade in May confirms that exports of United Kingdom goods reached a value of £228,900,000. Taking April and May together, the monthly average value of exports was £226,900,000, or 1 per cent higher than the monthly average for the first quarter. For the first five months of this year, the export rate was nearly 8 per cent above that of the first half of 1953, although it was only 2 per cent above the average for the second half of 1953. The Board of Trade has calculated that, in April and May, the export volume was 2 per cent greater than the monthly average in the first quarter of this year and only about 1 per cent below the high rate reached in the last quarter of 1953.

The Board of Trade says that the increase of United Kingdom exports this year has been mainly in engineering products. The April total for this class of exports maintained the increase recorded in the first quarter of the year, and in May there was a further rise of over £1,000,000 despite a fall in the value of exports of ships and boats of over £2,000,000. In the first quarter of this year, the increase over 1953 was chiefly in exports of machinery—especially electrical machinery—agricultural tractors, aircraft engines, and refrigerating and office machinery. Since March, however, the principal increase has been in shipments of road vehicles, exports of which rose from a value of £24,000,000 a month in January and February to £28,500,000 in May. There are three factors, the Board comments, which have contributed to this expansion. First, the end of the winter check to exports of cars to Canada (although shipments of passenger cars to Canada in the first five months of this year were 34 per cent less than in the corresponding period of 1953) ; secondly, the seasonal increase in demand for British cars in the markets of Western Europe, as a result of which exports of cars to these markets in May were valued at nearly double the average of January and February ; and thirdly, the further relaxation of Australian import restrictions, which has led to the doubling of car exports to Australia, both in number and value in the same period. The expansion of the Australian market has also been an important factor in the increase of metal exports by £1,000,000 a month between the first quarter of this year and April and May, most of the increase being in shipments of iron and steel.

Another matter mentioned in the Board of Trade report is that there was an increase of £2,000,000 in exports of chemicals in May over April, which already showed an improvement over the first quarter. Comparing the first five months of this year with the first half of 1953 there was an increase in the value of chemical exports of £2,000,000 a month, or 15 per cent. Most of that increase has gone to sterling countries, particularly Australia, India and New Zealand, but there have also been increases in the quantities of chemicals shipped to Western Europe, chiefly Western Germany and Sweden, and to the Argentine and Egypt. This expansion of chemical exports has been shared by all the principal sections of the trade with the exception of fertilisers.

Exporting to Canada

Some further observations on Canadian markets for consumer and capital goods are made in the current issue of the *Board of Trade Journal*. It is pointed out that successful selling in Canada depends on the adoption of methods suited to the market, and that procedures effective in the United Kingdom, or in other markets, may easily turn out to be inadequate and even detrimental.

Reference is made by the Board of Trade to Canada's need of large quantities of raw materials, capital equipment and consumer goods. Canadian Government statistics show that imports from the United Kingdom last year reached a value equivalent to £165,000,000, which was an increase of about 26 per cent over the 1952 figure, and constituted a new record. Nevertheless, that total represented only about 14 per cent of Canadian commodity imports, whereas the U.S.A. supplied 74 per cent of Canada's purchases abroad. It is therefore suggested that there should be plenty of room for United Kingdom exports to expand.

The comments on the various commodities required by Canada include some suggestions about the sale of capital equipment. It is stated that large United States and European exporters have built up efficient sales organisations in Canada, and that most United States firms have developed technical help for their customers, their service facilities giving them a decided advantage over their overseas competitors, with few exceptions. The suggestion is made that British manufacturers should not use European practices as a yardstick for Canada, because of costs of distribution in Canada, but, the *Board of Trade Journal* says, factors improving Canadian business are the services given at all stages to the user, the frequency and promptness of delivery, the wide selections and the amount of advertising and sales promotion of the distributors. The discount granted to the agent or dealer from the manufacturer is practically the same in Canada as in the U.S.A.—that is, ranging from 10 per cent to 12½ per cent and upwards. Standard machines are often sold by Canadians at the price of the United States list, plus the duties, taxes and freight, if any. The concluding comment is that the most satisfactory method of selling industrial products manufactured in the United Kingdom is to set up a Canadian branch in a selected centre, carry stocks, supervise sales and have fully qualified engineers so that complete service may be ensured.

Machinery Imports from the Dollar Area

Some modification of the licensing restrictions on the import of machinery from the dollar area has been announced this week in a written Parliamentary reply by Mr. Heathcoat-Amory, Minister of State, Board of Trade. The reply says that the Government thinks it of the greatest importance that British industry should be well equipped and believes that re-equipment can usually be carried out with British-made machinery.

At the same time, the Minister says, the Government, whilst unable in the present balance of payments situation to remove licensing restrictions on imports of dollar machinery, considers that some of the existing restrictions can be relaxed. Accordingly, in future, more favourable consideration will be given to applications for import licences whenever the Board of Trade is satisfied, from the information before it in each case, that a machine from the dollar area will reduce costs, and that no alternative "non-dollar" machine offering roughly similar advantages is available.

Coal Stocks and Imports

Last Monday, in the House of Commons, the Minister of Fuel and Power, Mr. Geoffrey Lloyd, answered several questions concerning the country's coal situation. He said that, compared with last year, consumption so far this year had been greater by 3,000,000 tons, and production by 1,000,000 tons. Exports and bunkers had remained about the same and total distributed and undistributed stocks of coal were now 1,500,000 tons less than a year ago. The Minister added that the Government had been considering for some time the coal prospects for next winter, and he had already authorised further imports. He could not, however, give information about the quantity or source of supply of those imports as he was anxious to give the National Coal Board the best commercial opportunities to get the coal as cheaply as possible.

In a supplementary question, the Minister was asked if his attention had been drawn to a statement made last week-end by Mr. Horner, general secretary of the National Union of Mineworkers, to the effect that the coal situation was now the most dangerous since 1946. In his reply to that question, the Minister recalled that earlier this year the union assured the Coal Board that it would regard a 2½ per cent increase of output this year as the minimum standard for which to aim. So far, the Minister said, there had not been any increase in output save for the extra 1,000,000 tons which resulted from there having been no Coronation holiday this year. Recently, the miners' leaders had reaffirmed their determination to ask for what they had suggested earlier in the year.

The latest report by the Ministry of Fuel and Power shows that last week the output of deep-mined coal was 4,286,000 tons, and of opencast 234,700 tons, making a total of 4,520,700 tons. In the first twenty-four weeks of this year the total coal production was 107,286,500 tons, compared with 106,309,500 tons in the corresponding period of last year.

Industrial Explosives in the U.S.A.

The United States Bureau of Mines has reported that consumption of industrial explosives reached a new record last year, the total of all kinds used being 790,810,690 lb. It is stated that the coal mining industry continued to be the principal consumer of industrial explosives, this one industry using 32 per cent of the total amount sold in the U.S.A. last year. The mining of coal in the U.S.A. in 1953 took 250,577,666 lb of all kinds of explosives, of which amount 54 per cent was high explosive other than permissible, 35 per cent permissible, 2 per cent black blasting powder, and 9 per cent liquid oxygen. The metal mining industry used 167,419,249 lb of explosives in 1953, which was 11 per cent more than in the preceding year.

Profit-Sharing Schemes

At the annual meeting of Imperial Chemical Industries, Ltd., which was held last week, Dr. Alexander Fleck mentioned, in his chairman's address, the profit-sharing scheme for employees which the company proposes to introduce. He said that any scheme which gave employees a cash sum regularly each year would suffer from the disadvantage that the receipt of the sum would become a normal expectation and would lose the character of profit sharing. If for any reason the amount had to be reduced or withheld altogether, there would be widespread comments among employees, probably suggesting hardship. At the same time, any scheme which distributed each year very large numbers of exceedingly small holdings in the company would be unsatisfactory and difficult to administer.

Dr. Fleck went on to explain that the proposed scheme put the net bonus to the credit of the employee in the accounts of trustees appointed for the purpose and provided for the issue of a stock certificate to the employee himself only when the account reached a reasonable figure. The board believed that such a scheme was more likely to induce employees to retain their holdings of stock than one in which the shares were issued each year direct to the employees. The board did not believe, Dr. Fleck continued, that the existence of the profit-sharing scheme would have a direct effect upon the amount of work done or the productivity of individual workers ; that was not its purpose. There were other means, he said, of encouraging hard work and good work, including the scientific application of work study. The scheme did, however, serve a purpose which, though less tangible, was no less important. In the long run, Dr. Fleck said, the health of a company's economy depended upon the wholehearted co-operation of workers, management, stockholders and customers. The part played by each element was very imperfectly understood, and misunderstandings could cause deep-rooted malaise which could undermine the country's economic health and stability.

Notes and Memoranda

Rail and Road

ROAD RESEARCH LABORATORY LECTURE COURSES, 1954–55.—The lecture courses to be held at the Road Research Laboratory, Harmondsworth, during the autumn and winter of 1954–55 will deal with the fundamental properties of road materials, and will include the most recent results of research, and their application in modern practice. A course on traffic and road safety of seven days' duration will also be held (this course is designed for senior officials, or those specially concerned with matters related to traffic engineering and/or road safety), and there will be two three-day courses on the stabilisation of soil with cement, arranged in co-operation with the Cement and Concrete Association. Each course will be self-contained. Forms of application can be obtained from the Director, Road Research Laboratory, Harmondsworth, Middlesex.

DOVEHOLES TUNNEL.—The London Midland Region of British Railways states that heavy repairs to Doveholes tunnel are to be made. This 1¾ miles long tunnel is situated on the Peak Forest-Derby-Manchester line between Millers Dale and Chapel-en-le-Frith. It was opened eighty-eight years ago and is on a gradient of 1 in 90, being driven through rock and brick-lined. The brickwork has been badly affected by water, which seeps through fissures in the rock and is led away by a culvert. The repair work which has been planned will take about three years to complete and will involve the closing of the tunnel for eight hours nightly. About eighty men will be employed. Before the actual cutting out of the defective brickwork can be done, steel ribs made of old permanent way rails are to be erected to carry the lagging or timber to support the brickwork. When this operation is completed, the brickwork will be cut out in sections by one gang of men, who will be followed by a gang of bricklayers building back the cut-out brickwork.

Air and Water

SHAW SAVILL LINER.—We are informed by the Shaw Savill Line that its new 20,000-ton liner will be given the name "Southern Cross" by The Queen when Her Majesty launches the ship from the Belfast yard of Harland and Wolff, Ltd. The ship, when completed, will sail under the command of Sir David Aitchison, K.C.V.O., who was captain of the "Gothic" during the Royal Commonwealth Tour.

SURVEY OF CANALS AND INLAND WATERWAYS.—The British Transport Commission says that the board which it appointed to undertake a survey of its inland waterways has held several meetings and is now paying visits to the waterways. It is intended at a later date to consider the views of a number of bodies interested in the subject. Lord Rusholme is chairman of the board. Mr. W. L. Ives has been appointed secretary and communications should be addressed to him at 22, Dorset Square, London, N.W.1.

AIR AND WATER POLLUTION STUDY.—The Organisation for European Economic Co-operation announces that a mission composed of eleven members representing seven member countries, is on a six-weeks tour of the United States to study the treatment of air pollution. The mission, while not intending to examine the treatment of water pollution as such, will, nevertheless, study the relevant inter-state and international regulations in force in North America. This mission has been planned under the O.E.E.C. technical assistance programme.

INTERNATIONAL AERIAL SURVEY CONFERENCE.—Delegates from many parts of the world are attending the aerial survey conference of the Hunting Group of Companies which is being held in London between June 21st and July 3rd at the Royal Aero Club Aviation Centre, Londonderry House, Park Lane, W.1. The conference has been called to enable the associated companies of this Group overseas to exchange ideas on the development of aerial survey techniques and equipment. Aerial survey work has been undertaken by the Hunting Group in forty different countries during the last twelve months.

GREATER FREEDOM FOR HELICOPTERS OVER LONDON.—Helicopters are now exempted from complying with the minimum altitude rules laid down when flying over part of the London area, subject to certain conditions. This exemption allows helicopters to operate more freely outside the central area of London, to fly across London via the River Thames, and to use the South Bank. The exemption applies only to flights within a radius of 10 nautical miles of Hyde Park Corner and outside the area bounded by straight lines joining the following points :—Kew Bridge, the eastern extremity of Brent reservoir, Gospel Oak Station (B.R.), south-east corner of Springfield Park, Bromley (Bow) station (B.R.), south-west corner of Hither Green, Herne Hill Station (B.R.), Wimbledon Station (B.R.), north-west corner of the Castelnau reservoir, Kew Bridge, and also to flights over the River Thames at any point within the above radius. Helicopters operating under this exemption must be flown so that in the event of the failure of a power unit they can alight without danger to persons, property or buildings on the ground or vessels on the water, and in any case may not be flown below a height of 1000ft above the ground or water except whilst over the River Thames, when they may not be flown below a height of 500ft above the water, and when taking off or landing at the South Bank. With the co-operation of the London County Council a landing area on the South Bank site at Waterloo is being established temporarily as a Government aerodrome open to helicopters, subject to twenty-four hours' notice being given by intending users to the Ministry of Transport and Civil Aviation.

Miscellanea

ADEN REFINERY.—We are informed that preparations are being made to berth the first tankers at the 5,000,000 tons per annum Aden refinery of the Anglo-Iranian Oil Company, Ltd. The ships are expected to arrive in July; one vessel will bring fuel for the refinery furnaces and another will deliver the first cargo of crude oil.

PLATFORMER FOR SHELL HAVEN REFINERY.—Work has started on the construction of a "platformer" at the Shell Haven oil refinery of the Shell Petroleum Company, Ltd. The plant, which consists of three sections, namely, feed preparation, reaction and stabilisation, will reform feed stock into high quality petrol in the presence of a platinum catalyst.

CHEMICAL PLANT.—Monsanto Chemicals, Ltd., announces that it is to construct a plant to manufacture maleic anhydride by the direct oxidation of benzene. The plant to manufacture the new material, which is a basic industrial chemical used for the manufacture of alkyd and polyester resins employed in the paint and plastics industries, will be built at the company's factory at Ruabon, North Wales.

MODEL ENGINEERING IN SCHOOLS.—A booklet entitled "Model Engineering as an Aid to Group Work in Schools" has been despatched to all technical colleges in this country by our contemporary, *The Model Engineer*. This booklet deals with the planning of group work in schools and accompanies an announcement that the organisers of "The Model Engineer" Exhibition propose to donate a student cup to be presented annually for work carried out by students and apprentices.

INDUSTRIAL ART BURSARIES.—The Royal Society of Arts has published details of its 1954 industrial art bursaries competition, in which prizes totalling £2500 are offered. These prizes take the form of travelling bursaries, usually of £150 each, the competition being open to students who intend to take up industrial designing as a career. The particulars of the competition may be obtained from the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2. The closing date for entries is October 11th.

INSTITUTE OF COST AND WORKS ACCOUNTANTS.—The Institute of Cost and Works Accountants announces that its fifth annual residential summer school is to be held at St. Catharine's College, Cambridge, from September 20th to 25th. The programme includes a paper on the problems of compiling, selling and distribution costs, by Mr. W. L. Spalding; another on the use of selling and distribution costs, their presentation and the testing of their effectiveness, by Mr. J. D. Gould, and a paper on marginal costing and price fixing by Mr. F. Spink. Mr. F. C. Hooper, vice-chairman of the British Institute of Management, will also speak. A works visit to Pye, Ltd., will take place during the week.

FOREMEN'S CONFERENCE.—The tenth management meeting for foremen, arranged by The Brush Group, Ltd., was recently held at the firm's Loughborough works. It was attended by nearly forty foremen from the group's factories in this country. An inaugural address was given by Mr. Ian T. Morrow, deputy managing director of the group. It was followed by talks on personnel management in Nigeria by Miss B. N. Seear, of the London School of Economics; shop floor problems, by Mr. Victor Feather, assistant secretary to the Trades Union Congress; employment and the law, by a partner from the company's solicitors; and present-day sales problems by Mr. J. P. Ford, managing director of the group's export companies.

TEACHING MACHINE SHOP ENGINEERING.—The Regional Council for Further Education in the South-West, in collaboration with the Gloucestershire Education Committee, is arranging a vacation course on "The Teaching of Machine Shop Engineering." This course will last from July 11th to 20th, most of the sessions being held at the School of Technology of S. Smith and Sons (England), Ltd., near Cheltenham. Some sessions will be held at the North Gloucestershire Technical College, The Woodlands, Cheltenham, and the students will be accommodated at Rosehill, the hostel of St. Paul's Training College, Cheltenham, where the evening lectures will be held. The course is open to full-time teachers of machine shop engineering in South-West England, and if there are vacancies a number of teachers from other parts of the country may be admitted. In addition to lectures on different aspects of machine shop engineering, the course will include opportunities for practical work and visits to engineering firms in the neighbourhood.

AUTOMATIC TUB STOP.—Pit bottom arrangements at collieries where tubs or cars are carried in the cage side by side usually include on the empties' discharge side of the shaft double tracks leading from the cage and converging on to a single track. At this point a collision will occur between tubs that have been discharged together unless extra men are employed or compressed air devices are used to control the flow. Mr. Leslie Smith, area planning engineer of the North Eastern Divisional Coal Board (Castleford Area), has designed a tub stop which is operated automatically by the descending cage and dispenses with the need for extra men or compressed air devices and does not need the attention of the onsetter. When the cage reaches the pit bottom it depresses a lever which raises an axle catch in track "A" to arrest the empty tubs on that side. At the same time a depresser slide in track "B" is lowered so that it is just clear of the tub axles. This slide prevents the axle catch in track "A" being lowered until the tubs on track "B" are past the depresser slide, although the cage has before then been raised from the pit bottom. In operation the tubs on track "B" are allowed to pass first and the tubs on track "A" are held until the tubs from track "B" are clear of the track junction, regardless of the period of time the cage remains in the bottom. The National Coal Board states that the device can also be designed to operate on the surface to control full tubs, in which case it is operated by the ascending cage.

SHIN-CAITHNESS TRANSMISSION LINES.—The Secretary of State for Scotland has confirmed a scheme prepared by the North of Scotland Hydro-Electric Board to connect the five generating stations to be built under the Board's Loch Shin Project in Sutherland and to extend the Board's Highland Grid. It will enable supplies of electricity from the Board's hydro-electric stations to be sent to Caithness, at a cost of £1,702,000. Overhead transmission lines will run from the main generating station of the Loch Shin Scheme at Inveran to the generating station at Ben Hee. Cables and overhead lines will connect this line with the other generating stations at Lairg and Cassley and the Garvault generating station will be connected to the station at Ben Hee. Transforming stations will be built at Inveran, Lairg, Cassley and Ben Hee. The extension of the Board's Highland Grid will be from the main generating station at Inveran to Mybster, south of Halkirk in Caithness, where a transforming station will be built. A White Paper on the scheme is available from H.M. Stationery Office, 13A, Castle Street, Edinburgh.

Personal and Business

BLUE STAR LINE, Ltd., states that it has acquired a substantial interest in Airwork, Ltd.

MR. B. F. SLATER has been appointed sales engineer, in the West of England, of J. and H. McLaren, Ltd., Leeds.

MR. A. W. MCMURDO, A.M.I.C.E., has been appointed district engineer at Shrewsbury, Western Region of British Railways.

BRITISH TYRE AND RUBBER COMPANY, Ltd., announces the appointment of Mr. Jack Etchells as deputy manager of its Glasgow branch.

MCKECHNIE BROTHERS, Ltd., Rotton Park Street, Birmingham, announces the appointment of Mr. G. C. Walton as sales manager.

MR. R. E. BUELL has been appointed controller of the technical division of the Regent Oil Company, Ltd., 117, Park Street, London, W.1.

MR. W. KENNETH G. ALLEN, joint managing director of W. H. Allen Sons and Co., Ltd., has been appointed to the board of Wessoe, Ltd.

THE JUNIOR INSTITUTION OF ENGINEERS has now moved to its new premises at 14, Rochester Row, London, S.W.1 (telephone, Victoria 0786).

SCOTTISH OILS, Ltd., announces that Mr. Robert Crichton, who retired recently, has been succeeded as managing director by Mr. John M. Caldwell.

VAUXHALL MOTORS, Ltd., Luton, states that Mr. H. T. Johnson, manager of the forward planning and development division, has been appointed a director.

HONEYWELL-BROWN, Ltd., has opened an additional office at 26, Blythswood Square, Glasgow. Mr. D. J. Venning has been appointed district superviser in charge of the office.

THE SOLAR AIRCRAFT COMPANY, San Diego, California, has opened a European branch office at 8, Clarges Street, London, W.1 (telephone, Grosvenor 7938). Mr. Patrick Johnson is the manager.

THE MINISTRY OF TRANSPORT AND CIVIL AVIATION announces the appointment of Mr. H. C. Adams, M.I.C.E., as assistant chief engineer at headquarters in succession to Mr. C. S. Chettoe, M.I.C.E., who is retiring.

MACKAY INDUSTRIAL EQUIPMENT, Ltd., Faggs Road, Feltham, has been appointed sole distributor in England, Wales, Northern Ireland and Eire of the Pescara-Muntz air compressor manufactured by Alan Muntz and Co., Ltd., Feltham.

LLOYD'S REGISTER OF SHIPPING states that Mr. W. E. J. Lewis, B.Sc., the Society's Principal Surveyor of Metals, is to retire on June 30th, after completing twenty-eight years' service. He is to be succeeded by Mr. T. W. Bushell, who is the Surveyor for Metals at headquarters.

ELLIOTT BROTHERS (LONDON), Ltd., announces the appointment of Mr. E. B. Schofield as area sales engineer for Lancashire, Cheshire and the West Riding of Yorkshire. Mr. Schofield is at the company's Manchester office at 66, Deansgate, Manchester, 3 (telephone, Blackfriars 7752).

THE BRUSH GROUP, Ltd., states that Dr. J. M. S. Risk has been appointed controller of accounts in succession to Mr. Maurice Tattersfield, who is now deputy managing director of Brush Electrical Engineering Company, Ltd. Dr. Risk has also been appointed a director of Associated British Oil Engines, Ltd.

THORN ELECTRICAL INDUSTRIES, Ltd., states that it has made an agreement with Sylvania Electric Products, Inc., whereby colour television cathode-ray tubes will be manufactured in this country. A new company, entitled Sylvania-Thorn Colour Laboratories, Ltd., is to be responsible for this work.

THE YALE AND TOWNE MANUFACTURING COMPANY, Willenhall, Staffs, announces that its future activities will be carried on by two divisions, the British Lock and Hardware Division and the British Materials Handling Division. Mr. H. Gilbert Ramsell has been appointed general manager of both divisions.

British Patent Specifications

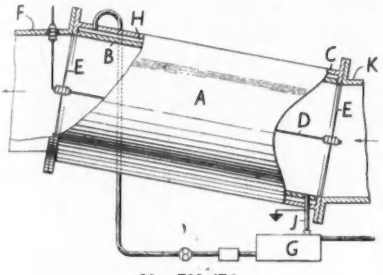
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.

ELECTRICAL ENGINEERING

709,476. January 5, 1951.—ELECTROSTATIC PRECIPITATORS, Power Jets (Research and Development), Ltd., 25, Green Street, London, W.1. (*Inventor: Derek Roy Whittet.*)

The invention relates to an electrostatic gas cleaner or precipitator wherein gasborne particles are precipitated on to a wetted collecting surface under the action of an electrostatic field. The drawing shows the invention in its simplest form. The cleaner consists of a double-walled circular section tube *A*, the inner wall *B* of which is made of a liquid-pervious material while the outer wall *C* is impervious. The tube is formed with end flanges, whereby it is connected to inlet and outlet ducts and is mounted with its axis at a small angle to the horizontal. A tensioned wire *D* is mounted coaxially within the tube,



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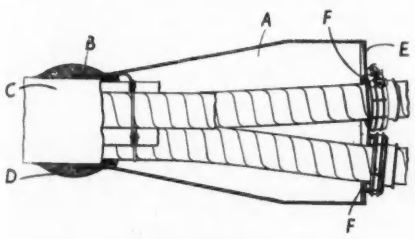
being carried at its ends in insulators which are supported by spiders *E* respectively, extending across the ends of the tube. One end of the wire is connected to a h.t. supply by a lead carried by an insulator in the wall of the outlet duct *F*. The wire is thus maintained at a high potential while the inner wall *B* of the tube is maintained at earth potential. The space between the inner and outer walls of the tube is supplied with a liquid which will percolate through the inner wall. Distilled water is used and a recirculation system is provided. This comprises a supply tank *G* from which the water is pumped by a pump through a filter to an inlet pipe leading into the space *H*. The water percolates through the wall *B* and forms a thin film on the inner side and eventually returns to the tank by a drain *J*. A small additional supply of distilled water may be continuously added to the tank from the inlet pipe to compensate for losses by evaporation. In operation, gas to be cleaned is passed into the tube *A* through duct *K* and leaves by duct *F*, as shown by the arrows. The deposited particles are continuously carried away and there is no chance of a deposit building up on the wall of the tube. Since the whole exterior surface of the liquid-pervious tube *B* is always immersed in liquid, no dry patches should appear on the inner surface. Modified multiple designs are also shown in the specification.—*May* 26, 1954.

707,715. July 14, 1952.—OIL-RETAINING FITTINGS FOR OIL-FILLED ELECTRIC CABLES, Pirelli-General Cable Works, Ltd., 343/5, Euston Road, London, N.W.1; and Percival Francis Hillyard, of this company.

As shown in the drawing, the oil-retaining fitting is made of sheet metal and has a conical portion *A* with

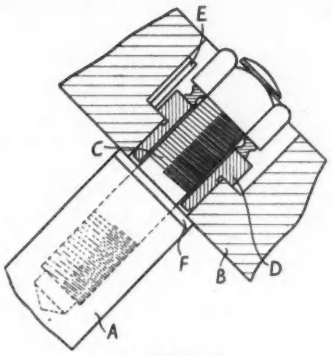


No. 707,715

an aperture *B* at the narrow end embracing the sheath *C*, of lead, enclosing the cable cores. The casing is attached to the sheath by a wiped joint *D*. The wider end of the casing is closed by a metal plate *E* secured by a soldered joint. In the plate there are three apertures *F* appropriately spaced so that the cable cores may extend through them. Each of the apertures is formed with an upstanding flange and between the core and the ring there is inserted a flexible ring of neoprene or other material not susceptible to attack by oil and of U-shaped cross-section. The ring forms a gland of the hydraulic cup type, whereby leakage of oil is prevented. As indicated, a collar with a cylindrical portion embracing the ring is secured in position by a circumferential clip or other appropriate retaining member.—*April* 21, 1954.

708,734. June 22, 1951.—DYNAMO ELECTRIC MACHINES, The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2; and Robert Ledger, of The General Electric Company, Ltd., Engineering Works, Witton, Birmingham.

In the drawing, the invention is shown applied to a d.c. traction motor in which interpole pieces *A* are secured to the frame *B* of the machine with a gap interposed in the magnetic circuit between the interpole piece and the frame, each interpole piece being secured in position by means of a stud *C*. The securing stud of magnetic material is arranged to extend through a radial hole in the frame, as is standard practice. The bore of the hole is stepped and to maintain the stud out of contact with the frame,



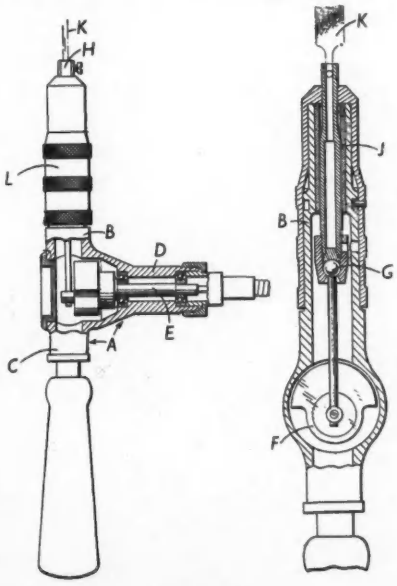
No. 708,734

the smaller diameter bore accommodates a bush *D* of brass. The bush has a hexagonal flange, which lies against the step in the hole and is prevented from undue rotation by a locking strip *E*. The locking strip is secured in position against the step of the hole by back welding to the wall of the bore. In order to prevent contact between the interpole piece *A* and the inner face of the frame *B* a brass washer or liner *F* is provided. There is thus provided a dynamo in which the interpoles are rigidly fixed in position suitable for heavy duty applications and in which the interpole is maintained out of magnetic contact with the frame of the machine by non-magnetic spacing means providing the necessary gap.—*May* 12, 1954.

WORKSHOP TOOLS AND APPLIANCES

709,853. March 21, 1952.—RECIPROCATING FILING MACHINES, Garringtons, Ltd., Albert Works, The Green, Darlaston. (*Inventor: John Charles Sharman.*)

This invention relates to reciprocating filing and the like machines of the kind comprising a reciprocable member arranged to cause reciprocation of a cutting tool and coupled to a connecting-rod also



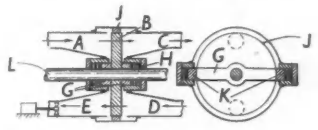
No. 709,853

associated with a driven crank pin or eccentric. Such machines may conveniently be constructed so as to be portable and as such are manually held so that the cutting tool can be directed to perform preferably finishing operations on stationary workpieces such as die blocks. An object of the invention to provide a reciprocating filing machine in which a reciprocable cutting tool carried by the machine can be rotatably adjusted relative to the body of the machine about an axis parallel with the reciprocatory movement, and whilst the machine is in operation or at rest. As the drawing indicates, the portable reciprocating filing machine comprises a "T"-shaped tubular body *A* having extensions *B* and *C* in which a handle is secured, and *D* in which a shaft *E* is driven by a flexible cable or an air motor. To the inner end of the shaft is secured a flywheel *F* arranged to carry a crank pin to which is secured one end of a connecting-rod whose other end carries the ball member *G* of a ball-and-socket joint. The reciprocable tubular tool holder *H* is slidably supported by a bearing bush *J* and at its forward end the bore of the holder is adapted to receive the shank of a cutting tool *K*. In use, the machine is held by the handle and the sleeve *L*. Whilst the tool and its holder are being reciprocated by the connecting-rod it may be desirable to rotate the tool and this may be effected, without moving the machine body, simply by rotating the sleeve *L* the required amount. During the rotary movement of the tool holder the socket of the ball-and-socket joint rotates around the ball member *G*, whilst at the same time the connecting-rod may be oscillated about the axis of the ball member by rotation of the crank pin.—*June* 2, 1954.

INTERNAL COMBUSTION ENGINES

709,638. September 11, 1951.—COOLING SCAVENGING AND CHARGING AIR, Crossley Brothers, Ltd., Openshaw, Manchester 11, Herbert Desmond Carter and Samuel Henry Henshall, both of the company's address.

The object of the invention is to provide improved means for cooling the scavenging and charging air which obviates the necessity for a cold water supply. The scavenging and charging air enters the rotary heat exchanger at *A*, passes through the rotary element *B* in which heat exchange takes place, and leaves by the passage *C*. Atmospheric air enters the device at *D*, passes through the rotary element *B* and leaves at *E*. The atmospheric air flow is assisted

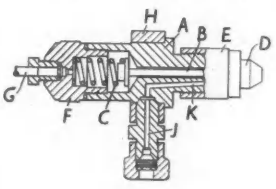


No. 709,638

by a fan. The element *B* may be in the form of a matrix of wire gauze or other material. In the drawing each of the opposite surfaces of the disc element *B* is divided into two parts by a cross member *G* which is loaded by a spring *H* so that the two streams of scavenging and charging air and atmospheric air respectively are separated at the disc faces. The peripheral edge of the disc is sealed by a ring *J*. A good joint is made with the ends of the cross members *G* by spring loaded pads *K*. The disc *B* is revolved with the driven shaft *L*. A modified design is also shown in the specification.—*June* 2, 1954.

709,650. September 26, 1951.—LIQUID FUEL INJECTION NOZZLES, C.A.V., Ltd., Warple Way, Acton, London, W.3. (*Inventor: William Frederick Shelton.*)

The object of the invention is to facilitate the manufacture of the body part of injection nozzles. Referring to the drawing, the main part *A* of the body of



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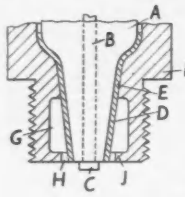
the nozzle is made from round bar and is bored to receive a stem *B* loaded by a spring *C* holding on its seating a discharge valve located in a nipple *D* adapted to be secured to one end of the main part of a sleeve *E*. At the other end is a screwed cap *F* which serves as an abutment for the spring and has a vent *G* for returning to a drain any liquid fuel which may seep past the stem. The attachment flange *H* is made as a separate part. Parts *A* and *H*

are brazed together. Within the branch piece is formed a bore *J* leading to a passage *K* in the main part whereby the incoming fuel can be led to the nipple *D*. At its outer end the branch piece is provided with a union nut for connection to a fuel supply pipe.—*June* 2, 1954.

709,829. October 5, 1951.—LOW-VOLTAGE SPARKING PLUGS, Joseph Lucas (Industries), Ltd., formerly known as Joseph Lucas, Ltd., Great King Street, Birmingham, 19. (*Inventor: John Andrew Laird.*)

The object of the invention is to enable scouring action to be accentuated and comprises a sparking plug in which an annular gas pocket surrounding the sleeve is provided with a restricted entrance adjacent to the spark gap. In the drawings the insulator *A* has an axial bore, and through this bore extends a metal stem *B*, which at its outer end is connected to a source of electrical energy. At its inner end the stem is provided with a head *C* which abuts closely against the inner end of the insulator.



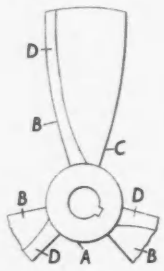
No. 709,829

The adjacent portion of the insulator is embraced by a metal sleeve *D* forming the other electrode. The parts of the electrodes form an annular gap, and the spark discharges occur across the narrow exposed intermediate surface of the insulator. As shown, the sleeve is a separately formed piece placed on the insulator and adapted at the end remote from the gap to fit closely an annular shoulder *E* in the body *F* of the plug. Alternatively it may be formed integrally with the body. In either case the sleeve and the adjacent portion of the body form between them an annular gas pocket *G*, the open end of which is adjacent to the spark gap. According to the invention, the pocket surrounding the sleeve is formed with a restricted entrance *H*, so that the gas on moving into and out of the pocket is caused to flow at high velocity over the gap, and thus effect a vigorous scouring action on the gap. The restriction may be formed by a metal ring secured in a circumferential groove in the body of the plug, or it may be formed as shown by an annular shoulder *J* made integral with the body at a position surrounding or adjacent to the gap. A modified design is also shown in the specification.—*June* 2, 1954.

MARINE ENGINEERING

709,709. August 23, 1950.—SCREW PROPELLERS, Gunnar Christian Engstrand, Box 63, Tottenville, Staten Island, Richmond, New York, U.S.A.

According to the invention, there is provided a propeller having its blades of substantially constant width throughout their length, the width of the blades being substantially equal to half the distance between the helical paths described by the pitched blades at each revolution. In the drawing is shown a high-speed marine propeller, which is composed of a hub *A* with three blades *B*, arranged as shown. The propeller is keyed to a shaft and is preferably provided with a fairing locknut. The three blades are formed with leading edges *C* and trailing edges *D*, conforming to the three generating helices. These helices are the helical paths described by the pitched blades at each revolution and are always the same distance apart. In the longitudinal cross section of the blade an increase of thickness at the root withstands the bending on the blades. The pitch of each blade increases toward the axis of rotation and the blade is of uniform width substantially from root to tip. The various features of the invention are applicable to propellers for aircraft and for fluid circulation in general.—*June* 2, 1954.



No. 709,709

Technical Reports

The Magnetic Compass Error Caused by D.C. Single-Core Sea Cables (Ref. B/T 116). By F. Busemann, Dr.-Ing. British Electrical and Allied Industries Research Association, Dorking Road, Leatherhead, Surrey. Price 10s. 6d., postage 3d. The use of a single conductor cable of the proposed a.c. cross-Channel link between Great Britain and France has been contemplated for a trial d.c. transmission with sea returns. The magnetic field due to the direct current in the cable would lead to errors of magnetic compasses of ships near the cable crossing. In this report the magnitude of the fields and of the error has been calculated. The calculated error of magnetic compasses caused by d.c. single-core cables operating with 100A at a depth of 25 fathoms is 1·3 deg. on the surface above the cable if the cable goes from north to south. The error is proportional to the current and to the cosine of the angle between the cable and a north-south line, and inversely proportional to the depth. It decreases rapidly with increasing distance from the cable. Return current through the sheath or through a second conductor in the same cable reduces the field of the first conductor according to its magnitude. The return current, however, almost entirely leaves the sheath on the first mile from the station on a 25-mile crossing, unless the sheath is insulated from earth. The reductions of the magnetic field of the conductor by the residual sheath current and the sea return current are negligible in the centre of the crossing. The field of a second single-core cable carrying the return current is negligible on the surface above the first cable if the distance between cables is large as compared with the depth of the water above them.

The Effect of an Open-Circuited Section on the Distribution of Surge Voltage in a Continuous-Disc Transformer Winding (Ref. S/T 72). By E. L. White, B.Sc. (Eng.), and T. J. Brown, B.Sc. British Electrical and Allied Industries Research Association, Dorking Road, Leatherhead, Surrey. Price 18s., postage 4d.—Tests were carried out on a continuous-disc winding with uniform insulation. The sections open-circuited contained up to 25 per cent of the turns and were symmetrically disposed about a break at the mid-point. Oscillograms of voltages to earth and between tappings in the open-circuited discs were recorded with the recurrent-surge oscillograph. As compared with the full winding, voltages to earth were not materially different, though voltages between tappings tended to be lower. The voltage across the break was found to reach 35 per cent of the applied voltage, where only 7 per cent of the turns were open-circuited. Nearly 100 oscillograms of voltages between selected tappings were analysed into component frequencies by inspection. A few were also analysed by a mathematical method, which is outlined in an appendix. As the number of open-circuited discs was increased from zero the fundamental and odd harmonics were unchanged, as anticipated from theoretical considerations, but the even harmonics were replaced by an equal number of new modes of oscillation, the frequencies of which varied considerably. These variations are discussed. A few tests made with tapping risers connected to the winding showed a slight improvement in the surge voltage distribution.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

AIRCRAFT BOLTS WITH UNF. THREADS

This consecutive series of British Standards deals with the general requirements, manufacture, heat treatment and testing of mushroom-head, pan-head and countersunk head bolts in steel, corrosion resisting steel, and aluminium, all of which have UNF. threads. No. A.113 : 1954. Price 3s. "Steel Mushroom-Head Bolts (UNF. Threads) for Aircraft." No. A.114 : 1954. Price 3s. "Corrosion-Resisting Steel Mushroom-Head Bolts (UNF. Threads) for Aircraft." No. A.115 : 1954. Price 3s. Aluminium Alloy Mushroom-Head Bolts (UNF. Threads) for Aircraft." No. A.116 : 1954. Price 2s. 6d. "Steel Pan-Head Bolts (UNF. Threads) for Aircraft." No. A.117 : 1954. Price 2s. 6d. "Corrosion-Resisting Steel Pan-Head Bolts (UNF. Threads) for Aircraft." No. A.118 : 1954. Price 2s. "Aluminium Alloy Pan-Head Bolts (UNF. Threads) for Aircraft." No. A.119 : 1954. Price 3s. "90 Deg. Countersunk-Head Steel Bolts (UNF. Threads) for Aircraft." No. A.120 : 1954. Price 3s. "90 Deg. Countersunk-Head Corrosion-Resisting Steel Bolts (UNF. Threads) for Aircraft." No. A.121 : 1954. Price 3s. "90 Deg. Countersunk-Head Aluminium Alloy Bolts (UNF. Threads) for Aircraft."

SHEAR BOLTS AND NUTS FOR AIRCRAFT

The British Standards below specify the materials, dimensions, finish and testing of shear bolts and nuts for use on aircraft and contain details of the method of identification. A.112 provides a range of steel bolts, cadmium-plated, to be suitable for insertion in aluminium alloy materials. No. A.109 and A.110 : 1954. Price 5s. "Shear Bolts and Nuts (Unified Hexagons and UNF. Threads) for Aircraft." No. A.112 : 1954. Price 3s. "Cadmium-Plated Shear Bolts (Unified Hexagons and UNF. Threads) for Aircraft."

Contracts

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., Rugby, has received a third contract from the U.S. Army European Headquarters Command for mobile fire control radar, type A.A. No. 3, Mk. 7, valued at £2,020,000. The total value of the three orders received is £4,975,000.

THE GENERAL ELECTRIC COMPANY, Ltd., of England, is to supply microwave radio relay equipment to transmit television programmes in Canada between London and Windsor, Ontario. The order has been obtained by the Canadian General Electric Company, Ltd., the main contractor for the scheme, jointly from Canadian National Telegraphs and Canadian Pacific Telegraphs. The link, which will employ similar equipment to that used on the Swiss "Eurovision" link supplied by the G.E.C., will incorporate four relay stations. It will carry 525-line pictures in black and white, or in colour. The installation is to be carried out in three stages: a one-way link, a second link in parallel which is reversible, and the conversion of the first link into a reversible system.

Catalogues

F. BODE AND SON, Ltd., Leek, Staffordshire.—Catalogue of welding positioners.

G. AND J. WEIR, Ltd., Cathcart, Glasgow.—Booklet entitled "Feeding the Modern Boiler."

METALLISATION, Ltd., Pear Tree Lane, Dudley, Worcs.—Metal spraying by the British wire process.

FILTAVAC, Ltd., 64a, Kensington Church Street, London, W.8.—Filtavac portable industrial vacuum cleaners.

GEORGE W. KING, Ltd., Stevenage, Herts.—Leaflet giving details of "Marvex" electric chain pulley block.

RUDKIN AND RILEY, Ltd., Aylestone, Leicester.—Brochure describing Rudkin and Riley die shop equipment.

REFRIGERATOR COMPONENTS, Ltd., 534, Stretford Road, Manchester, 16.—General refrigeration catalogue, 1954.

SUNVIC CONTROLS, Ltd., 10, Essex Street, Strand, London, W.C.2.—Leaflet describing the Sunvic liquid-level controller.

CAMBRIDGE INSTRUMENT COMPANY, Ltd., 13, Grosvenor Place, London, S.W.1.—Sheet No. 312, Cambridge humidity indicators.

WATSON, MANASTY AND CO., Ltd., Richmond Road, Kingston-on-Thames, Surrey.—Leaflet describing the "Shadowmaster" profile projector.

HACKBRIDGE AND HEWITTIC ELECTRIC COMPANY, Ltd., Walton-on-Thames, Surrey.—Publication No. R.248, Hewittic rectifiers for mining service.

HEAD WRIGHTSON ALUMINIUM, Ltd., Teesdale Iron Works, Thornaby-on-Tees.—Booklet entitled "The Application of Light Alloys to Engineering."

A. REYROLLE AND CO., Ltd., Hebburn, Co. Durham.—Copies of pamphlets No. 1236, Class "GP" cartridge fuse links; No. 1254, Solkor-B feeder protection; and No. 1280, variable-speed a.c. commutator.

LANCASHIRE DYNAMO AND CRYPTO, Ltd., Trafford Park, Manchester, 17.—List A.1, stock list of standard S.C.R. and slip-ring motors and leaflet describing L.D.C. motors for mechanical handling equipment.

Forthcoming Engagements

Secretaries of Institutions, Societies &c., desirous of having notices of meetings inserted in this column, are requested to note that in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

INSTITUTE OF METALS

Wed., June 30th.—GENERAL MEETING: 4, Grosvenor Gardens, London, S.W.1, "The Brittle Fracture of Metals: Some New Developments," E. Orowan, 5 p.m.

END OF VOL. 197

The Engineer

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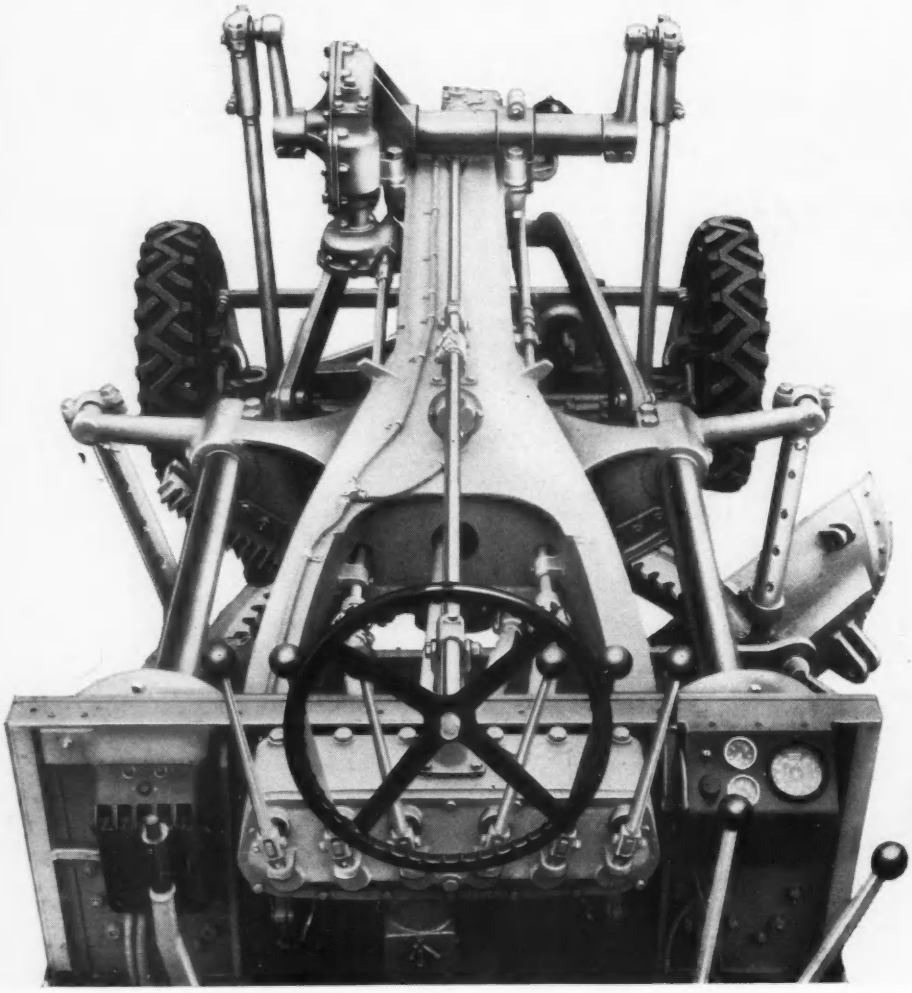

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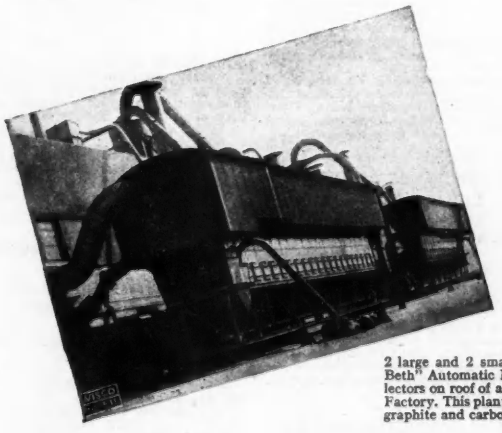

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All letters intended for insertion in 'The Engineer' or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications. No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

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Advertisements received by Mid-day Tuesday will appear in the issue of Friday the same week. Orders must be accompanied by a remittance.

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PUBLIC APPOINTMENTS

WOLVERHAMPTON AND STAFFORDSHIRE TECHNICAL COLLEGE

Principal: C. L. OLD, B.Sc. (Eng.), M.Sc.Tech.

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G. W. R. LINES,
Clerk to the Joint Education Committee.
Education Offices,
North Street,
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1st June, 1954. E9285

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WORK STUDY SCHOOL

LECTURING STAFF

The Work Study School, The College of Aeronautics, Cranfield, Beds, wishes to make additional appointments to the Lecturing Staff. Candidates should have sound experience in the application of modern work study techniques in industry and, if possible, should have some experience of lecturing on technical subjects. Graduates would be given special consideration since facilities for research are available. In due course, but not immediately, a small house on site will be made available. The salary offered, dependent upon experience and qualifications, would be not less than £1000 per annum, with superannuation under F.S.S.U. Applications, giving age and personal record, should be addressed as above (postal address, Cranfield, Bletchley, Bucks), not later than 15th July. E9270

WORCESTERSHIRE EDUCATION COMMITTEE

COLLEGE OF FURTHER EDUCATION, BROMSGROVE

GRADE A ASSISTANT TEACHER

College of Further Education, Bromsgrove, Engineering Department : Grade A ASSISTANT TEACHER required for general engineering subjects. Good industrial experience essential.

Application forms may be obtained from the Director of Education (S/J), County Education Office, Castle Street, Worcester, on receipt of tsamped, addressed foolscap envelope. (P.243). E9241

PRODUCTION ENGINEERING RESEARCH ASSOCIATION

RESEARCH ENGINEERS

Production Engineering Research Association, vacancies for RESEARCH ENGINEERS Applications are invited from Engineers to undertaye research on machine tools, machining processes, pressworking of metals and allied subjects. Candidates should have a First or Second-Class Honours Degree. For men with initiative there are g od opportunities for advancement. Superannuation under F.S.S.U. Full details, including age, experience, qualifications and salary required to Secretary, P.E.R.A., Melton Mowbray. E9255

PUBLIC APPOINTMENTS

HER MAJESTY'S COLONIAL SERVICE

NYASALAND

CIVIL ENGINEERS

Applications are invited for the following posts :—
CIVIL ENGINEERS, Nyasaland.

Vacancies exist in the Roads and Airfields Branch of the Public Works Department. Duties include administration, design and construction of roads and ancillary works.

SENIOR EXECUTIVE ENGINEER.

Appointment on contract/gratuity terms. Salary £1600 per annum plus £195 10s. cost-of-living allowance. Candidates, who should be between the ages of 35 to 45, must hold a University Degree or Diploma in Civil Engineering recognised as granting exemption from the Final Parts I and II of the A.M.I.C.E. examination. Candidates should have considerable experience and preference will be given to those with overseas experience on road bridges and low-cost roads.

EXECUTIVE ENGINEERS.

Appointment either on probation for permanent and pensionable establishment or on contract/gratuity terms. Salary according to age, qualifications and experience in the incremental scale £695–£1515 per annum, plus cost-of-living allowance varying between £92–£195 10s., according to salary. Candidates, who should be between the ages of 21–38, must hold a University Degree or Diploma recognised as granting exemption from, or have passed, Final Parts I and II of the A.M.I.C.E. Preference will be given to candidates with overseas experience on road bridges and low-cost roads.

There are also vacancies for keen young ENGINEERS who have recently graduated and are anxious to study road engineering. They will be considered at appropriate starting salaries.

Terms of service : free passages, £30 outfit allowance if starting salary less than £975, generous leave, length of contract 2-3 years, renewable by mutual agreement. Gratuity payable on satisfactory completion of contract at the rate of £25 for each three months of satisfactory service or at the increased rate of £37 10s. on salaries of £1000 or over.

Full details on application.

Apply in writing to the Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, giving briefly age, qualifications and experience. Mention the reference number BCD/112/4/011/D4 and state the post applied for. E9261

CIVIL SERVICE COMMISSION

SENIOR SCIENTIFIC OFFICERS SCIENTIFIC OFFICERS, PATENT EXAMINER AND PATENT OFFICER CLASSES

The Civil Service Commissioners invite applications for pensionable appointments. Applications may be accepted up to 31st December, 1954, but early application is advised as an earlier closing date may eventually be announced. Interview Boards will sit at frequent intervals. The Scientific posts cover a wide range of scientific research and development in most of the major fields of fundamental and applied science. In biological subjects the number of vacancies is small : individual vacancies exist at present for candidates who have specialised in palaeobotany, foraminifera, malacology and lichenology. The Patent posts are in the Patent Office (Board of Trade) and Ministry of Supply.

Candidates must have obtained a University Degree with First or Second-Class Honours in an appropriate scientific subject (including Engineering) or in Mathematics, or an equivalent qualification ; or, for Scientific posts, possess high professional attainments. Candidates for Senior Scientific Officer posts must in addition have had at least three years' post-graduate or other approved experience. Candidates for Scientific Officer and Patent posts taking their Degrees in 1954, may apply before the result of their degree examination is known.

Age limits : Senior Scientific Officers, between 26 and 31, but specially suitable candidates under 26 may be admitted. For Scientific Officers and Patent Classes, between 21 and 28 during 1954 (up to 31 for permanent members of the Experimental Officer class). Salary (London) : Senior Scientific Officers (men), £975–£1150 ; (women), £845–£1025. Scientific Officers (men), £470–£855 ; (women), £470–£750. Patent Examiner and Patent Officer Classes (men), £440–£760 (rates under review). Women's rates somewhat lower. Somewhat lower rates in the provinces.

Further particulars from the Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. S.53/54 for Senior Scientific Officers and S.52/54-S.128/54 for theother posts. E9272

MINISTRY OF SUPPLY

EXPERIMENTAL ESTABLISHMENTS

MECHANICAL ENGINEERS

MECHANICAL ENGINEERS required by Ministry of Supply for Experimental Establishments, mainly in Southern England, for research, design and development of a wide range of civil and military equipment, including aircraft, armaments, fighting vehicles, gas turbines, guided weapons, rockets and accessories. Appointments according to qualifications and experience as Scientific Officer (1st or 2nd Class Honours Degree or equivalent in Mech. Eng.), £445–£815 ; Assistant Experimental Officer (Higher School Cert. (Science) or equivalent—Higher National Certificate or a pass Degree may be an advantage), £276 (age 18) to £615. Experimental Officer (H.S.C., &c.—min. age 26), £690–£850. Women somewhat less. Min. academic quals. quoted essential. Experience should be connected with appropriate research or development. Appointments unestablished. F.S.S.U. benefits may be available for S.O. class. Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting C 673/53A. E9072

PUBLIC APPOINTMENTS

CITY OF BRADFORD

ENGINEERING ASSISTANTS

Applications are invited for the following appointments in the City Engineer and Surveyor's Office, on the grades indicated :—

(a) ENGINEERING ASSISTANT, Post No. 120, Grade A.P.T. III, IV or V (£550/£595, £580/£625 or £620/£670), according to qualifications.

Candidates should preferably hold an Engineering Degree, have passed the Intermediate or Final Examination of Inst.C.E. or Inst.Mun.E., and have had experience of modern methods of road construction and/or main drainage works, must be good draughtsmen and capable of preparing bills of quantities and contract documents.

(b) TWO JUNIOR ENGINEERING ASSISTANTS (Posts Nos. 62 and 63), Grade A.P.T. I, II, III or IV (£490/£535, £520/£565, £550/£595 or £580/£625), according to qualifications.

Applicants should have had general experience in municipal engineering and be good draughtsmen.

(c) ENGINEERING ASSISTANT (DRAINAGE), £900 per annum, on the temporary staff.

Must be chartered civil engineers and/or chartered municipal engineers, and should have had experience in the design and supervision of sewerage schemes of some magnitude.

The appointments are superannuable. Applications, on the prescribed form, to be obtained from the City Engineer and Surveyor, Town Hall, Bradford, 1, together with three testimonials, must be received by the undersigned not later than 1st July, 1954.

All candidates should have completed their National Service.

No housing accommodation can be provided by the Corporation.

W. H. LEATHEM,
Town Clerk.
Town Hall,
Bradford, 1. E9296

BRITISH ELECTRICITY AUTHORITY

LONDON DIVISION

(VACANCY No. 54/471)

CONSTRUCTION DEPARTMENT DIVISIONAL HEADQUARTERS

SENIOR ASSISTANT ENGINEER (MECHANICAL ENGINEERING)

Applications are invited for the above superannuable post. Conditions of service in accordance with N.J.B. Agreement, Schedule C. Salary includes London Allowance.

Applicants should have considerable experience in generating station construction work, including the preparation of station and system layouts and specifications for all types of mechanical plant, handling of contracts and supervision of site erection. Some station operating experience would be an advantage. Preference will be given to engineers with an Engineering Degree or Corporate Membership of the Institution of Mechanical Engineers. Salary : Class AX, Grade 1 : £1018 10s./£1153 p.a., rising ultimately to Class EX, Grade 1 : £1282 p.a.

Applications, quoting vacancy number, may be made on form obtainable from Divisional Secretary, British Electricity Authority, London Division, Generation House, Great Portland Street, W.1, and be received within 14 days of this advertisement. E9276

PRISON COMMISSION

CIVILIAN INSTRUCTIONAL OFFICERS

CIVILIAN INSTRUCTIONAL OFFICERS : (a) Fitter, and (b) Machinist, required for General Engineering Workshop at Wakefield Prison. Applicants must be at least 30 and under 50 on 21st July, 1954, have served a full apprenticeship and have had not less than five years' industrial experience. Knowledge of jig and tool-making and maintenance of machines required for post (a) and the machining of jigs and tools, together with experience in setting-up machines required for post (b). The holding of a City and Guilds of London Institute certificate or equivalent considered an additional qualification.

Annual salary : £550 by four annual increments to a total of £640, inclusive, payable monthly ; 44-hour week ; 18 working days paid annual holiday, rising to 24 days after three years' service ; quarters not provided. Appointment unestablished (non-pensionable) but establishment considered after period of satisfactory service.

Application forms returnable by 9th July, 1954, may be obtained from Establishment Officer (R212/74A), Prison Commission, Horseferry House, Dean Ryle Street, London, S.W.1. Applicants should state for which post they wish to be considered. E9273

FURNITURE DEVELOPMENT COUNCIL

RESEARCH ENGINEER

A RESEARCH ENGINEER is required for experimental work on questions connected with domestic furniture. Applicants should possess a Higher National Certificate in Mechanical Engineering or its equivalent and should preferably have had some experience in experimental or development work ; age 21–30. Initial salary £500/£600, depending on qualifications and experience.—Applications to The Director, Furniture Development Council, 11, Adelphi Terrace, W.C.2. E4161

CENTRAL ELECTRICITY BOARD

FEDERATION OF MALAYA

Attention is drawn to the post for DEPUTY STATION SUPERINTENDENT, details of which appear on page 71. E9265

PUBLIC APPOINTMENTS

HER MAJESTY'S COLONIAL SERVICE

NIGERIAN RAILWAY

ASSISTANT LOCOMOTIVE SUPERINTENDENT

To assist the District Superintendent (Locomo in the general administration of a District. Res ible for maintenance of locomotives and inspe of steam pumps used in connection with supplies.

Appointment is either pensionable or on co in the scale £730 by £40 to £1290 per annum, addition of 20 per cent for contract appoint An expatriation allowance varying between £350 per annum is also payable. On co appointment a gratuity of £100–£150 per ann payable on satisfactory completion of con Free first-class passages for officer and his wife an annual maintenance allowance or free pa allowance up to £75 each is payable in respe a maximum of two children. Furnished qu available at rental charge of 10 per cent of salary. Leave is granted at rate of seven days each month of residential service after tour of months.

Candidates for pensionable appointment sh be between the ages of 26–40 years and be A Mech.E. or have taken Parts A and B of the exa tion for Associate Membership and be pre to qualify during probation. For contract app ment the professional qualification and age limi be waived if compensated by wide experience.

Candidates should have served an apprentic and pupilage in a first-class locomotive repair shop and thereafter have had footplate and run shed experience, and have worked at least two on administrative duties in a locomotive run department. Drawing office experience an advan

Opportunities for rapid promotion in the ranks of Nigerian Railways are good. The gressive growth of traffic and the wastage in posts due to normal retirements combined to excellent opportunities for advancement to m approved worth.

Apply in writing to the Director of Recruit Colonial Office, Great Smith Street, London, S giving briefly age, qualifications and exper Mention the reference number BCD.110/14/03 E9

CITY OF BIRMINGHAM

PUBLIC HEALTH DEPARTMENT

SMOKE AND FACTORIES INSPECTO

Applications are invited for the above posts candidates possessing the Board of Trade (S Engineering Certificate, or its equivalent. Ap tions from qualified sanitary inspectors h the Royal Sanitary Institute Smoke Inspe Certificate will also be considered.

The duties include advisory and enforc duties in connection with the abatement of spheric pollution from fuel burning furnaces trade processes, also the abatement of indu noise and the testing of appliances as an Auth Officer under the Heating Appliances (Fire Gu Act, 1952.

The candidates should have a good knowled the combustion of fuels and furnace design, a capable of examining plans and specifications o industrial fuel burning installations.

Salary within A.P.T. Grades I to V (£490 to per annum), according to qualifications and e ence ; pension scheme, including widow orphans', medical examination.

Applications, stating age, qualifications, p appointment and salary, length of service experience, together with the names of two ref should be sent to the Medical Officer of H Public Health Department, Congreve Street, mingham, 3, not later than 5th July, 1954. E

ELECTRICAL RESEARCH ASSOCIATION

GRADUATES IN PHYSICS, ENGINEERI MATHEMATICS OR PHYSICAL CHEMISTRY

Applications are invited by the Electrical Res Association from GRADUATES in Physics, neering, Mathematics or Physical Chemistry fundamental and applied research in various as tions of electricity. Starting salaries are from to £600 p.a. for those without post-graduate fications, or from £600 to £800 p.a. for those higher qualifications. Appointments are eligib superannuation under the F.S.S.U.—Applic should be made to the Director, E.R.A. Labor 5, Wadsworth Road, Greenford, Middlesex. E4

LONDON TRANSPORT

NEW WORKS ENGINEER'S CIVIL ENGINEERING SECTION

TEMPORARY TECHNICAL ASSISTA

London Transport require TEMPORARY T NICAL ASSISTANTS for New Works Engi Civil Engineering Section. Duties comprise ca out of surveys, design and preparation of dra and specifications in connection with construc works. Salary £343 10s. at 21, rising to £613 subject to age and satisfactory service, with tional payments for certain recognised qualifica medical exam.—Applications to Staff Officer (289), London Transport, 55, Broadway, S.W.1 acknowledgment enclose addressed envelop E

PUBLIC APPOINTMENTS

HER MAJESTY'S COLONIAL SERVICE

EAST AFRICAN RAILWAYS AND HARBOURS ADMINISTRATION (BCD.173/06)

ASSISTANT MECHANICAL ENGINEERS

ities for one post (a) are the supervision of repair workshops and inspection of civil neering machinery and plant; for other posts de duties are of a general nature as Assistants running and workshops sections of the mechani- department of a railway. Appointments are nable on probation in the salary scale £650– per annum, point of entry depending on fications and experience. A cost-of-living ance of 35 per cent. of salary is payable to a mum of £350 per annum. Free accommodation vided if available. Free passages once each ach tour for officer, his wife and children up adult fare. Leave at rate of 4½ days for each of resident service.

ndidates for (a) should be between the ages of d 45 and should be A.M.I.Mech.E. They d have workshop experience, and a thorough ledge of operation, maintenance and major ails of mechanical plant used for civil engineer- works, including road transport vehicles, earth- g equipment, 2ft. gauge locos, electrical g sets, &c. Experience is also necessary in e workshop accounting storekeeping and l staff administration. Candidates for (b) d be between the ages of 25 and 30 and must passed or be exempt from Parts A and B of Associate Membership examination of the ution of Mechanical Engineers and have served pprenticeship with a British-owned railway or of locomotive builders, followed by a minimum d of four years' experience in locomotive tion and maintenance. They should have held of responsibility in the mechanical department ailway of recognised standing.

ndidates should apply in writing to the Director cruitment, Colonial Office, S.W.1, giving brief s of age, qualifications and experience. E9247

ATOMIC ENERGY RESEARCH ESTABLISHMENT

HARWELL

APPOINTMENTS

portunities exist on a wide variety of mechanical, ical, electro-mechanical, electronic and chemical work, including checking duties on electronic lectro-mechanical work. Vacancies exist in the UGHTSMAN, LEADING DRAUGHTSMAN SENIOR DRAUGHTSMAN grades, with maxima £640, £742 and £910 respectively.

rther details (including information on starting and application forms available on request from lishment Officer, A.E.R.E., Harwell, Berkshire. te 2/103/98). E4176

BRITISH ELECTRICITY AUTHORITY HEADQUARTERS

DRAUGHTSMEN

itish Electricity Authority Headquarters, Bank- London, require DRAUGHTSMEN for work ither :—

Civil and building works in connection with or grid substations, or

Electrical layouts and diagrams for grid sub- ons.

ary, N.J.B., Grade 6, Schedule "D": £458 to (inclusive), according to qualifications and ience. Pension scheme. One Saturday morning ur on duty. Forms from D. Moffat, Director stablishments, Winsley Street, London, W.1. e Reference AE/491/E. E9275

PRODUCTION ENGINEERING RESEARCH ASSOCIATION

TECHNICAL ENQUIRY SECTION

ENGINEER

oduction Engineering Research Association has cy for an ENGINEER in the Technical iry Section, which deals with a wide variety of uction problems for member firms. Good rtunities for advancement for man with initia- Superannuation under F.S.S.U. Full details , experience, qualifications, salary required, &c., retary, P.E.R.A., Melton Mowbray. E9256

LONDON COUNTY COUNCIL

IL AND STRUCTURAL ENGINEERS

IL and STRUCTURAL ENGINEERS re- d, with experience in general civil engineering or in design and detailing of engineering struc- in concrete or steel. Application form from Engineer (54/26), London County Council, ty Hall, S.E.1, returnable within next 14 days. ose S.A.E.) (728). E9250

PEPPARD CHEST HOSPITAL

ASSISTANT ENGINEER

ppard Chest Hospital, near Henley-on-Thames, (244 beds). ASSISTANT ENGINEER re- d. Salary £425 by £15 to £500 p.a.—Forms of cation from Group Secretary, 3, Craven Road, ing, Berks. E653

PUBLIC APPOINTMENTS

MINISTRY OF WORKS

ENGINEERING DRAUGHTSMEN

ENGINEERING DRAUGHTSMEN required in London, Edinburgh, Glasgow and various provincial offices.

Candidates must have British nationality, technical standard of Ordinary National Certificate or equivalent, and apprenticeship or practical experience of at least three years, including one in a drawing office, in one of the following categories :—

Mechanical : Plant layout, boilers and steam distribution, pumps, rotating machinery, heavy and light mechanisms, servo systems and pressure vessels.

Electrical : Lighting and power installations, overhead and underground distribution systems and all types of equipment, instrumentation and controls.

Heating and Ventilating : All types of heating and/or ventilating systems, refrigeration and air conditioning.

London salaries (men), £420 (at age 21) to £670 p.a. Starting pay according to age and experience. Rates elsewhere slightly less. Prospects of promotion and permanency.

State age and full details of training and experience to W.G. 10/C.E. 10 (I), Ministry of Works, Abell House, John Islip Street, London, S.W.1. E9071

ADMIRALTY

ROYAL NAVAL SCIENTIFIC SERVICE

SENIOR SCIENTIFIC OFFICER AND SCIENTIFIC OFFICER

SENIOR SCIENTIFIC OFFICER and SCIENTIFIC OFFICER required in Experimental Establishments in London, Portsmouth, Weymouth and Gloucestershire areas and Scotland. The majority of posts are for Engineers and Physicists (particularly with Electronics). Candidates must be British subjects with an appropriate First or Second Class Honours Degree or equivalent high professional attainments. Salaries : S.S.O. (M), £975–£1150 ; S.O. (M), £470–£855. London rates. Somewhat lower in Provinces. All appointments are unestablished (with F.S.S.U.) but with some opportunities to compete for established posts. Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting A246/52/A. E9226

MINISTRY OF FUEL AND POWER

EXPERIMENTAL OFFICER (MALE)

Ministry of Fuel and Power require EXPERIMENTAL OFFICER (male), London. Higher National Certificate with three years' drawing office and mechanical engineering works ; experience on use of materials under high temperatures or stresses. Engineering apprenticeship or equivalent desirable. Duties : assisting development of pulverised fuel combustion and hot gas cleaning systems used with coal burning gas turbines ; design and operation of experimental rigs. Salary : £720–£890. Post unestablished. Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting Ref. C400/54A. E9271

BRITISH ELECTRICITY AUTHORITY

HEADQUARTERS

GENERAL ASSISTANT ENGINEER

British Electricity Authority, Headquarters, require a GENERAL ASSISTANT ENGINEER in the Generation Plant Design Sub-Branch to assist in investigations into design problems associated with turbines, condensers and feed heaters. Candidates, preferably with a Degree in Mechanical Engineering, should have some experience with a manufacturer of one of the above items of plant. Salary : N.J.B., Grade 5, £558–£769 p.a. inclusive. Forms from D. Moffat, Director of Establishments, British Electricity Authority, Winsley Street, London, W.1, to be returned by July 5th, 1954. Quote reference E/AE/454. E9251

DEPARTMENT OF ATOMIC ENERGY

ENGINEERS

ENGINEERS required by Department of Atomic Energy at Risley for work on major calculations required by design offices concerned with nuclear reactors and factories for producing fissile material. Subjects dealt with relate to fluid flow, heat transfer, nuclear radiation shielding and stress analysis. Qualifications : recognised engineering apprenticeship with A.M.I.Mech.E., and considerable engineering experience. Salaries : £960–£1240 or £620 (age 25) to £960, according to experience. Superannuation scheme. Applications to Department of Atomic Energy, Industrial Group Headquarters, Risley, Warrington, quoting 617. E9225

LONDON COUNTY COUNCIL

CIVIL ENGINEERS, CIVIL ENGINEERING ASSISTANTS AND DRAWING OFFICE STAFF

CIVIL ENGINEERS, CIVIL ENGINEERING ASSISTANTS and DRAWING OFFICE STAFF for design of large civil engineering works in connection with main drainage and sewage purification. Applications form from Chief Engineer (54/27), London County Council, County Hall, S.E.1, returnable within next 14 days. (Enclose S.A.E.) (727). E9061

PUBLIC APPOINTMENTS

BRITISH TRANSPORT COMMISSION

DOCKS AND INLAND WATERWAYS

HUMBER PORTS

POSTS IN THE DEPARTMENT OF THE CIVIL ENGINEER

Applications are invited for TWO POSTS in the Department of the Civil Engineer, Humber Ports, Hull, for men with experience of design of structures, either land or marine, in reinforced concrete, timber or steel. Salary up to £900 per annum, according to qualifications and experience. Contributory superannuation scheme.

Applications, giving details of age, experience and present position, should reach the Chief Docks Manager, British Transport Commission (Humber Ports), Dock Office, Victoria Square, Hull, not later than 14 days after the publication of this advertisement. E9267

LONDON TRANSPORT

CIVIL ENGINEERING SECTION

TEMPORARY ENGINEERING ASSISTANTS

London Transport require TEMPORARY ENGINEERING ASSISTANTS in Civil Engineering Section for design and construction of railway works. Applicants should be experienced in design and preparation of drawings, specifications and estimates for earthworks, bridges, &c.; preferably Members of recognised Professional Institution or possess similar qualifications ; capable of controlling staff and supervising works executed by contract. Salary range £635 to £719 10s. Prospects of advancement to £783 10s. Commencing salary according to qualifications and experience ; medical exam.— Applications to Staff Officer (F/EV.288), London Transport, 55, Broadway, S.W.1. For acknowledgment enclose addressed envelope. E9258

TENDERS

MINISTRY OF TRANSPORT AND CIVIL AVIATION

CONWAY BY-PASS—NEW BRIDGE AT CONWAY

The Minister of Transport and Civil Aviation invites TENDERS for the CONSTRUCTION of a new steel, Spandrel-braced, ARCH BRIDGE, 310 feet span and 31 feet 6 inches wide, with approaches, stone-faced retaining walls and all incidental works.

Drawings of the proposed works can be seen at the office of the Consulting Engineer, Mr. H. W. Fitzsimons, B.Sc., M.I.C.E., 39, Victoria Street, London, S.W.1, on week-days, excluding Mondays and Saturdays, from 29th June until 16th July, between the hours of 11 a.m. and 4 p.m.

Copies of the drawings and contract documents may be obtained at the above-mentioned address upon payment of a deposit of £15 by cheque or draft made payable to the order of the Minister of Transport and Civil Aviation. The deposit will be returned if a bona fide Tender is submitted and not subsequently withdrawn.

Tenders on the official form, which must be received before 4 p.m. on Tuesday, 10th August, 1954, should be sent in a sealed registered envelope marked "Tender for Conway New Bridge," addressed to the Assistant Secretary, Highways Development and General Division, 21–37, Hereford Road, Paddington, London, W.2.

The Minister does not bind himself to accept the lowest or any Tender.

S. R. WALTON,
An Assistant Secretary.
E9274

NORTH OF SCOTLAND HYDRO-ELECTRIC BOARD

DUNDEE AREA

SUPPLY, ERECTION & COMMISSIONING AT CAROLINA PORT GENERATING STATION

TENDERS are invited for the SUPPLY, ERECTION and COMMISSIONING at Carolina Port Generating Station, Dundee, of the following :—

Two 150,000 lb. per hour STEAM GENERATING UNITS and all ANCILLARY APPARATUS : Steam Receiver and Steam, Exhaust, Feed Water, Blowdown and Drain Piping ; Modifications to Bunkers, Coal and Ash-Handling Plant, &c.

Tender documents and drawings may be obtained on application to the undersigned on payment of five guineas, which will be refunded on receipt of a bona-fide Tender (which is not subsequently withdrawn) and the return of all documents.

Tenders should be delivered to the undersigned, together with all technical information required, in a sealed registered package, marked "Confidential," not later than twelve noon on Monday, 20th September, 1954.

The Board do not bind themselves to accept the lowest or any Tender.

P. PHILIP, M.I.Mech.E., M.I.E.E.,
Area Manager.

7, Dudhope Crescent Road,
Dundee,
June, 1954. E4173

TENDERS

VICTORIA FALLS ELECTRICITY BOARD

CONTRACT VF. 401

BUILDING AND CIVIL ENGINEERING WORKS

The Victoria Falls Electricity Board is prepared to receive TENDERS for BUILDING and CIVIL ENGINEERING WORKS required in connection with a forthcoming extension to their hydro-electric power station. The work involves extensions to the settling basin, pipe supports and anchors, building extensions and turbine foundations.

Forms of Tender, conditions of contract, quantities and drawings, may be obtained from the offices of the Engineers, Messrs. Mackness and Shipley, Parliament Mansions, Abbey Orchard Street, London, S.W.1, upon payment of £3 (cheque or draft only made payable to the Board), which will be returned on receipt of a bona fide Tender not subsequently withdrawn.

Tenders in plain, sealed envelopes, endorsed "Contract VF.401," must be delivered to the offices of the Board, Sackville House, Livingstone, N. Rhodesia, not later than noon, 30th July, 1954. No Tender will be considered from any firm unable to submit proof of satisfactory completion of similar works requiring a high standard of accuracy.

The Board do not bind themselves to accept the lowest or any Tender.

MACKNESS AND SHIPLEY
E9235 Consulting Engineers.

SALE BY TENDER

Two 7½-ton Diesel-engined RAIL CRANES, manufactured 1940, by Thos. Smith and Son, Ltd.
One SPINDLE MOULDER.
One BANDSAW.
One MECHANICAL SLOPER.
One SCREWING MACHINE.
One Underpressure WATER TAPPING "MACHINE."
One Portable Electric DRILLING MACHINE.
One PAINT SPRAY UNIT.
One Tecalemit RAMP and COMPRESSOR, 3½ ton.
One Double-Ended Electric GRINDING MACHINE.
One DRILLING MACHINE STAND.
One BELT GUILLOTINE.
One Wadkin BANDSAW BRAZING MACHINE.
One Westinghouse BATTERY CHARGER.
One PIPE BENDING MACHINE.
One CORRUGATED GUILLOTINE.

Further particulars and forms of Tender may be obtained from the Secretary, Wales and Monmouthshire Industrial Estates, Ltd., Treforest Trading Estate, Nr. Pontypridd, Glamorgan.

All the plant is situated at Wrexham Trading Estate, Nr. Wrexham, Denbighshire, and may be inspected at any time by arrangement with the Estate Manager (telephone number, Wrexham 3461).

The closing date for Tenders is 10 a.m. on 17th July, 1954. E4155

EDUCATIONAL

A.M.I.MECH.E., B.SC., CITY AND GUILDS, &c. Guaranteed postal courses for all Exams and Technical Divisions from Elementary to Degree Standard. Approximately 95 per cent. successes. 144-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E505 E

THE UNIVERSITY OF BIRMINGHAM

DEPARTMENT OF MECHANICAL ENGINEERING

GRADUATE SCHOOL OF THERMODYNAMICS AND RELATED STUDIES

A COURSE available in the above School provides facilities for the STUDY, at advanced level, of modern developments in THERMODYNAMICS and allied subjects and of their applications in the general field of the heat engine. The normal entrance qualifications are an Honours Degree in Mechanical Engineering, together with a minimum of two years of practical experience in industry. On completion of the twelve-month course commencing on the 4th October, 1954, and including nine months' attendance at the University, successful candidates qualify for the award of the Degree of Master of Science. In special circumstances applications may be considered from the graduates in other sciences holding satisfactory alternative qualifications. In the latter case it will usually be necessary for two years to be spent in completing the course. The award to successful non-graduate engineers is the Diploma of Graduate Studies.

The inclusive fee for the course of study is £71 1s. In certain cases where a student is not sponsored by an employer, the University may consider applications for the remission of this fee and, where essential, for the grant of a maintenance allowance during the period of attendance.

Further particulars and application forms may be obtained from the Registrar, The University, Edgbaston, Birmingham, 15. E4108 E

SITUATIONS VACANT

A CIVIL ENGINEER required for resident engineer's staff, pipeline and oil installation, North Midlands. Preferably aged 26–35, qualified, and having at least two years' construction site experience. Salary £650–£1000 p.a., according to experience.—Apply in writing, giving full details, to Regent Oil Co., Limited, 117, Park Street, London, W.1. E4162 A

BERMUDA ELECTRIC LIGHT CO., LTD.— Applicants are informed that both posts previously advertised have been filled. E4117

For continuation of Small Advts., page 4

SITUATIONS VACANT

NOTIFICATION OF VACANCIES ORDER, 1952

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18–64 inclusive or a woman aged 18–59 inclusive, unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order, 1952.

APPLICANTS ARE ADVISED TO SEND COPIES, NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A DESIGN & EXPERIMENTAL DRAUGHTSMAN is required by leading company of light engineers in the West of London area. Previous experience of hydraulics or high-pressure gas would be an advantage. Post is permanent and superannuated. Good commencing salary is offered. Apply in confidence, giving fullest details.—BOX No. E9282, "The Engineer." A

A DRAUGHTSMAN is required for interesting work in connection with reorganisation schemes and maintenance of steelworks plant, buildings and services. Applicants should be experienced in the design and layout of plant and machinery.—Written applications in the first instance, stating age, details of education, training and experience to date, should be addressed, in confidence, to the Personnel Manager, Hadfields, Ltd., East Hecla Works, Vulcan Road, Sheffield, 9. E9304 A

A LARGE COMPANY IN THE MIDLANDS has a vacancy for a qualified and experienced Metallurgist, to take charge of the metallography dept. of the metallurgical laboratory.—BOX No. E9311, "The Engineer." A

A QUALIFIED METALLURGIST is required, to undertake development work on small tools with a large company in the Midlands.—BOX No. E9318, "The Engineer." A

A VACANCY will shortly exist for a Chief A.I.D. Inspector in an expanding firm in the South London area. He should have, in addition to considerable inspection and administrative experience, either an Electrical Degree or diploma or a strong electrical instrument bias. Good salary and prospects. Write, giving full particulars and quoting reference I.C., to Personnel Officer.—BOX No. E9317, "The Engineer." A

A WELL-KNOWN COMPANY in the Birmingham area requires a Heating Engineer, having a Degree in Mechanical Engineering, to take charge of a small research and development group working on oil-burning problems. A substantial salary will be paid to a man having the required qualifications and experience.—Please write, giving all details, to BOX No. 900, 19–21, Corporation Street, Birmingham, 2. E9204 A

A WEST RIDING ENGINEERING COMPANY invites applications from Senior Machine Tool Draughtsmen for interesting and original design work. Applicants should preferably have experience in the preparation of specifications for quotation purposes and an opportunity will be afforded to suitable men to follow up inquiries. A pension and insurance scheme is in operation. Reply, giving details of experience and technical education, and stating age and salary required.—BOX No. E4169, "The Engineer." A

A YOUNG ENGINEER is required to work in a team engaged in design and development of electro-mechanical and electronic equipment for aircraft. Qualifications required are : (a) Sound technical background in light electrical or electronic engineering ; (b) imagination, initiative and energy ; (c) Inter B.Sc. or H.N.C., B.Sc., would be an advantage.—Please write, giving full particulars, to Personnel Officer, Louis Newmark, Ltd., Prefect Works, Purley Way, Croydon, quoting reference Y.E. E8588 A

AN ENGINEER OR PHYSICIST is required in our Research and Development Department for work on aircraft and other specialised equipment. Energy and drive essential and applicant must be capable of carrying out original ideas and be able to work on his own intiative. Degree desirable. Salary according to experience and qualifications.—Please write, giving full particulars, to the Personnel Officer, Louis Newmark Limited, Prefect Works, Purley Way, Croydon, quoting Reference D.2. E9091 A

AN EXPANDING WEST COUNTRY MANUFACTURING FIRM wishes to contact First-class Honours (only) Graduates in Science or Engineering who wish to make a career in the production field. Suitable candidates will be given full details and an opportunity to inspect the manufacturing process. Quote Ref. No. M.11.—BOX No. E9182, "The Engineer." A

APPLICATIONS ARE INVITED by the Vacuum Oil Company, Limited, for the following positions at its new refinery at Coryton, Essex :—Assistant Engineers : applicants must have a Mechanical Engineering Degree and experience preferably in either the petroleum or chemical process industry. However, applications from graduates who have recently left university will be considered (Ref. A.E.). Piping Draughtsmen : applicants for this position must have piping layout experience in petroleum or chemical process plants (Ref., D.M.P.). General Draughtsmen : wide engineering experience, particularly with reference to civil engineering, is required for this position (Ref., D.M.G.). All Draughtsmen applicants must have an O.N.C. and preference will be given to those who are studying for or have obtained an H.N.C. Salaries are progressive and opportunities for promotion excellent. Conditions of employment include a pension and life assurance scheme, sickness benefit plan and sports and social club.—Applications, giving full details of qualifications and experience, and quoting the appropriate reference, should be addressed to the Industrial Relations Superintendent, Vacuum Oil Company, Limited, Coryton Refinery, Coryton, Essex. E9290 A

APPLICATIONS ARE INVITED for the post of Assistant for Design Development on Machine Tools, required by a large machine tool manufacturer in Birmingham. Must be good draughtsman, with sound experience of designing for production. State in confidence full particulars, including age and salary required.—BOX No. E9300, "The Engineer." A

APPLICATIONS INVITED from Draughtsmen having O.N. or H.N. Certificate, for vacancy as Assistant to Engineer, age 20–24. The position offers permanency with good prospects and is with an old-established manufacturing company in 18 miles radius London. Apply, giving full particulars, in confidence.—BOX No. E4156, "The Engineer." A

APPLEBY-FRODINGHAM STEEL CO., Scunthorpe, Lincs, have vacancies for Senior and Junior Draughtsmen, with good technical qualifications and initiative for general mechanical engineering work. Staff pension scheme and welfare facilities available, also assistance with accommodation, if required.—Application to be addressed to the Works Employment Officer, giving full details of age, previous experience, and salary required. E9292 A

ARMSTRONG SIDDELEY MOTORS, Coventry, require Technical Assistants interested in the flight development of gas turbine aero-engines. The work covers all aspects of engine performance prediction, flight analysis, instrumentation and associated problems of turbo jet and turbo prop engines. Preferably, applicants should have reached an Engineering Degree or similar standard.—Apply to Reference TGD 1, Personnel Manager, Armstrong Siddeley Motors, Coventry. E9139 A

ASSISTANT CHIEF DRAUGHTSMAN required for a drawing-office engaged on the design and detailing of colliery surface plant, mechanical handling plant and steel structures. The position is permanent and offers scope for advancement to the right man. Salary in accordance with qualifications and experience. Pension scheme.—Apply to G. R. Turner, Limited, Langley Mill, Nottingham. E4160 A

ASSISTANT CIVIL ENGINEER required by London Consulting Engineers. Applicants should have good structural design experience, preferably including marine works and railway layouts, and should be Corporate Members of the Institution of Civil Engineers or possess equivalent qualifications. Good salary according to qualifications and experience.—Apply by letter only, marked "Design," with full particulars of age, qualifications and experience, to Rendel, Palmer and Tritton, 125, Victoria Street, London, S.W.1. E9319 A

ASSISTANT ENGINEER required for large London food factory. Must have served apprenticeship in mechanical engineering, and have a H.N.C. or equivalent, and Grad.I.Mech.E., or A.M.I.Mech.E. A good general engineering background essential, some electrical knowledge desirable ; age 25 to 32 years. Apply, stating age, experience and qualifications, to Chief Engineer.—BOX No. E4150, "The Engineer." A

ASSISTANT ENGINEER required for London office of consulting engineers. Applicants should have some design experience of highways and bridges and experience of steelwork design will be an advantage.—Apply by letter, with full particulars of age, qualifications and experience, to Rendel, Palmer and Tritton, 125, Victoria Street, London, S.W.1. E9227 A

ASSISTANT MECHANICAL DEVELOPMENT ENGINEERS required by The Steel Company of Wales, Limited (Steel Division), Port Talbot, for their Abbey Works, to undertake work relating to the improvement of efficiency and operation of all sections of the steelmaking and rolling mill plant. The works consist of a modern open-hearth melting shop with eight furnaces of 200-ton capacity, a 45in. slabbing mill, an 80in. wide continuous hot strip mill, a three-stand cold sheet mill, pickle lines, annealing furnaces, cut-up lines, temper mills, and other auxiliary equipment. Applicants should preferably have experience of both design and operation of a wide range of heavy mechanical equipment, but not necessarily steelwork plant. They should be able to initiate original designs from sound fundamental principles and prepare working sketches and data for final development in the drawing-office. Higher National Certificate or equivalent desirable. Salary will depend on age, experience and qualifications and will be in the region of £850 to £950 per annum.—Those wishing to apply should write for official application form to the Personnel Superintendent, The Steel Company of Wales, Limited, P.O. BOX No. 3, Port Talbot, Glam. E9239 A

ATTRACTIVE OPPORTUNITIES are available to suitably qualified men for the Computer Section of The English Electric Company, Ltd., Stafford Works :

(1) Engineers or Physicists experienced in light circuit electronics, preferably with University Degree, for work on computors. Previous experience not necessary.

(2) Engineers, with experience in light mechanisms, preferably with good knowledge of electronic circuitry.

(3) Mathematician with knowledge of electronics and with University Degree.

Housing assistance may be permitted for approval of successful applicants, and a pension scheme is in operation after qualifying period.—Application, with full particulars of experience age, &c., should be addressed to Dept. C.P.S., 336/7, Strand, W.C.2, quoting Ref. 1344. E9266 A

BOOTS PURE DRUG CO., LTD., Engineers' Department, Beeston, require a Designer-Draughtsman, aged about 30–35, with workshop and technical training, preferably to A.M.I.H.V.E. standard, able to undertake complete schemes of heating, ventilating and air conditioning with their associated controls and ductwork. Refrigeration experience in this field would be an advantage. Superannuation scheme, five-day week.—Apply, Personnel Manager, Station Street, Nottingham. E9278 A

BOOTS PURE DRUG CO., LTD., Engineering Department, Beeston, require a Mechanical Designer-Draughtsman, with workshop and technical training, preferably to H.N.C. standard, able to lay out in detail complete schemes of chemical plant, including pumps, pipework pressure vessels, and supporting steelwork. A practical knowledge of welding fabrication is essential and familiarity with enamelled and stainless steel equipment would be an advantage. Superannuation scheme, five-day week. — Apply, Personnel Manager, Station Street, Nottingham. E9277 A

BX PLASTICS, LTD., Brantham Works, near Manningtree, Essex, require Draughtsmen with broad mechanical engineering background and training. Good salaries to men of proved ability.—Apply, stating full details of training and experience, to the Personnel Manager at Brantham Works. E9191 A

BRITISH OXYGEN ENGINEERING, LIMITED
Angel Road, Upper Edmonton, London, N.18.

ESTIMATING ENGINEER AND ASSISTANT CONTRACTS MANAGER

Applications are invited from Chemical or Mechanical Engineers with considerable experience in estimating and tendering for chemical plant installations, for appointment as Assistant Contracts Manager. The Contracts Department is concerned with estimating and tendering for gas separation works and installations, and for general chemical plant.

The salary range for the post is commensurate with its importance.

Applications to Personnel Manager at the above address. E4181 A

BRITISH OXYGEN ENGINEERING, LIMITED
Angel Road, Upper Edmonton, London, N.18.

MECHANICAL ENGINEERS are invited to apply for appointment as Senior Test Engineer, responsible for the testing of chemical plant, including compressors and turbines, mainly related to gas separation plant installations.

Applicants should have served an engineering apprenticeship, have had previous experience on chemical plant and gas compressing units, preferably in a similar capacity to that outlined above, and hold an Engineering Degree or Membership of the Institution of Mechanical Engineers.

Applications should be addressed to Personnel Manager, giving particulars of age, qualifications, experience and salary required. E4178 A

BRITISH OXYGEN ENGINEERING, LIMITED
Angel Road, Upper Edmonton, London, N.18.

PROJECT ENGINEERS

Project Engineers with experience in the chemical plant field are invited to apply for a senior appointment in a construction group engaged in the construction and installation of gas separation and general chemical works. The post requires experience in the planning and co-ordination of projects combining civil, mechanical and chemical engineering phases and applicants should preferably hold a Degree in one or other of these fields.

Applications should be addressed to the Personnel Manager at the above address. E4180 A

CHEMICAL PLANT DRAUGHTSMAN, Senior required by consulting engineers for working in S.W. and E. London offices. Experience in plant layout, pressure vessels, piping, structures. Salary £650 to £800.—The Coniston Engineering Company, 72, Upper Tooting Road, S.W.17(Balham 6049). E4164 A

CIVIL ENGINEERING ASSISTANTS required by Westminster Consulting Engineers with experience in the design of one or more of the following : harbour and dock works, large dams, reinforced concrete and mass concrete structures. Salary according to experience. Five-day week. Pension scheme. Apply, stating age and experience.—BOX No. E9122, "The Engineer." A

CIVIL ENGINEER, SENIOR, required for consulting engineers. Experienced large industrial installations, piling and drainage. Salary range £750 to £850 per annum. Some of our design work is carried out on our clients' premises in East and Central London.—The Coniston Engineering Company, 72, Upper Tooting Road, S.W.17 (Balham 6049). E4163 A

COMMERCIAL ESTIMATORS (time-served engineers) required by large engineering firm in Glasgow. Experience essential in all types of steam plant auxiliary machinery. Interesting work with wide range of plant to be handled. Remuneration according to age and experience. Superannuation scheme, five-day week, canteen facilities.—Applications to Personnel Manager, G. and J. Weir, Ltd., Cathcart, Glasgow, S.4. E9252 A

CONSULTING ENGINEERS require (a) Assistant Civil Engineers, knowledge of sewerage and/or sewage disposal design an advantage ; (b) Civil Engineering Draughtsmen ; (c) Reinforced Concrete Designer-Draughtsmen (about 2 years' experience). Pensions scheme. Salaries according to experience and qualifications.—Apply in writing, with full details, to J. D. and D. M. Watson, 18, Queen Anne's Gate, Westminster, S.W.1. E9297 A

COURTAULDS LIMITED, Coventry, require for the chemical engineering section of the research department Engineering Draughtsmen for the layout of chemical engineering pilot plants and design of various mechanisms. Applicants should hold Higher National Certificate in Engineering. Age 21-25 years. Salary according to age and experience. Excellent prospects.—Write to Labour Officer. E9059 A

CROMPTON PARKINSON, LTD., have vacancies for both Senior and Junior Draughtsmen at their Chelmsford Works. Preference will be given to applicants having contract, development or diagram experience on switchgear up to 11kV, but adaptable men having good electrical and mechanical experience will be considered. Conditions of employment are ideal and prospects are good.—Apply, giving fullest particulars, to Personnel Officer, Crompton Parkinson, Ltd., Chelmsford Works, Essex. E4082 A

DESIGN AND DETAILS DRAUGHTSMAN required for site assignments at various locations, experienced in the undermentioned :—
(1) Pressure vessels and related pipework.
(2) Steel-framed structures.
(3) Reinforced concrete structures and foundations.
(4) H.T. and L.Y. electrical installations.
(5) Lights and medium mechanical engineering development.
(6) Industrial plant general services.
Full living allowances paid on site assignments. Positions permanent for suitable applicants ; preference given to single men, and choice of locations available. Write, stating age, experience, qualifications and present salary scale.—BOX No. E9242, "The Engineer." E

DESIGN DRAUGHTSMAN.—A vacancy exists in our design drawing-office for a first-class Design Draughtsman for interesting work associated with the development of automobile electrical equipment. He should be at least of H.N.C. standard and experienced in the design of light electrical equipment for large quantity production would be an advantage. The post provides excellent scope for initiative and advancement.—Reply, stating qualifications, experience and age, to Personnel Manager, Joseph Lucas Ltd., Gt. King Street, Birmingham, quoting reference PM/D/93. E62

DESIGN DRAUGHTSMEN—Markham & Co., Ltd., invite applications for several posts in their London office to work on heavy and medium general engineering. Applicants should have had experience in the development and design of special machinery and be capable of carrying out investigations in the predesign studies for various classes of work. Experience in heavy mechanical engineering in any of the following branches would be useful : colliery hoists, winding engines, haulages, colliery shaft equipment, heavy steelworks' plant, large slurry flow pumps, mechanical equipment for research, plant, heavy weldments, chemical plant, particularly large pressure vessels, heat exchangers. A working knowledge of the electrical equipment needed to drive or control these machines would be advantageous. Regard will be given to technical qualifications. Applicants should give their age, their present occupation, their present salary and details of their education and past experience, with dates to the month in year chronologically.—Applications will be treated in the strictest confidence and should be addressed to The Secretary, Markham and Co., Ltd., No. The Sanctuary, Westminster, London, S.W.1. E419

DESIGN DRAUGHTSMEN required by The Steel Company of Wales, Limited (Steel Division), Port Talbot, for maintenance and development work. Applicants should have experience of steelworks practice. Higher National Certificate or equivalent desirable. Permanent pensionable positions are offered to suitable men with rates varying according to age and qualifications, up to £675 per annum. Those interested should send full particulars of qualifications, experience, &c., to the Personnel Superintendent, The Steel Company of Wales, Limited, P.O. BOX No. 3, Port Talbot. E9

DESIGN ENGINEERS with experience of industrial hydraulic equipment and preferably some knowledge of sales engineering. Two Design are required, with possibility of overseas transfer to one of the suitable applicants. The posts are interesting with exceptional opportunities in a progressive firm in the south-western area. Four-figure salary dependent on the qualifications of the right man. Write to Chief Engineer, BOX 1R G.823, Adv., 212a, Shaftesbury Avenue, London, W.C. E9

DESIGNER-DRAUGHTSMAN, preferably experience on electro-mechanical instruments and components. H.N.C. (Mech.) standard with workshop training desirable. Good prospects and conditions with pension scheme. Location S.E. Lon Full particulars and salary required.—BOX E9306, "The Engineer."

DESIGNER-DRAUGHTSMEN wanted, experience of heavy engineering design and development. Knowledge of heavy steel mill plant is preferable. Good prospects for experienced men. five-day week, canteen and social club facilities.—A stating age, experience and salary required, &c., the Personnel Manager, T.I. (Group Services) Limited, Rocky Lane, Aston, Birmingham. E9

DESIGNERS

Experience of aircraft electrics or hydraulics would be an advantage, but not essential.

These appointments are pensionable and offer good prospects to individuals with initiative and technical ability.

Applications, giving details of experience and qualification, to :

Personnel Manager,
Joseph Lucas (Gas Turbine Equipment), Ltd.,
Shaftmoor Lane, Hall Green. E9

DESIGN ESTIMATOR SALES ENGINEER required for London office of leading fan manufacturer. Must be fully experienced in fans and collectors, especially boiler draught work. State age, previous experience and salary required. BOX No. E645, "The Engineer."

DEVELOPMENT ENGINEER required to research and development department of company engaged on work of national importance. By by birth. Education to at least H.N.C. standard essential. Some knowledge of explosives desirable but not essential as broad outlook, initiative and enthusiasm. Applications, stating full details of past experience and salary required, to the Manager Director.—BOX No. E9293, "The Engineer."

DEVELOPMENT ENGINEERS required, to undertake interesting work associated with the design of light electrical equipment. The positions provide plenty of scope for initiative and excellent prospects for advancement to senior appointments. Applicants should be Graduates in Engineering or have equivalent qualifications and while previous experience of a similar nature is desirable, consideration will be given to engineers without such experience. Please reply to Personnel Manager, Joseph Lucas (Electrical), Ltd., Gt. King Street, Birmingham, stating age, qualifications and experience, quoting reference PM/D/8. E6

DRAUGHTSMAN, Junior or Intermediate, practical training and general machinery experience for work on cardboard-box and carton-making machinery. Central London. Write full particulars of age, training and experience.—BOX No. E "The Engineer."

SITUATIONS VACANT

RAUGHTSMAN required for engineers' office. ust have some experience in process plant layout, eral mechanical design and factory maintenance. rrent A.E.S.D. rates and over to suitable applicant. nsion fund, sickness benefits, staff canteen, social cilities, &c.—Please apply in writing to Personnel nager, John Knight, Limited, Royal Primrose p Works, Silvertown, E.16. E4166 A

RAUGHTSMAN, SENIOR, first class, fully perienced in plant layout, including piping and ping circuits or heavy industrial chemical engi- ring, for interesting work on water-treatment t installations ; five-day week and pension eme. Attractive salary to the right man.—The rnutit Company, Limited, Gunnersbury Avenue, ndon, W.4. E9303 A

RAUGHTSMEN, aged 21 years and over, uired for work on petroleum and chemical plants follows : Layout, piping, instrumentation, ssure vessels and tubulars. Also Designers and ughtsmen for structural steelwork, preferably h knowledge of reinforced concrete.—Full par- ulars should be addressed to Head Wrightson ocesses, Ltd., 24/26, Baltic Street, E.C.1. E647 A

DRAUGHTSMEN

re invited to apply for appointment with the Plant Design Group of British Oxygen Engineer- g, Ltd., engaged on the design of

Gas Separation Plant

for a wide range of applications. The range of esign includes

Heat exchangers
Pressure vessels
Compressors
Pumps
High-pressure systems

nd the posts offer excellent scope in an interest- g and expanding field of work.

Applicants should have had experience in a similar field or, if in the age group 23–30 years, general mechanical experience will be considered.

Applications should be made in writing, giving details of experience, or in person to

THE PERSONNEL MANAGER,
BRITISH OXYGEN ENGINEERING, LTD.,
ANGEL ROAD, UPPER EDMONTON,
LONDON, N.18.

On main 'bus and train routes.

E4179 A

RAUGHTSMEN for Gwynnes Pumps, Ltd., coln and London.—Apply for interview either at llington Foundry, Lincoln, or 64, Chancellors ad, Hammersmith, W.6. Juniors acceptable. E651 A

RAUGHTSMEN required, experienced in design d detailing of mechanical handling conveying ipment, Knightsbridge area ; five-day week, cheon vouchers.—BOX No. E4147, "The Engi- r." A

RAUGHTSMEN REQUIRED for Albright Wilson, Ltd., Oldbury, Nr. Birmingham, for rk in the Central Engineering Department. Appli- ts should preferably be between 23 and 30 years age, and should have obtained their Higher tional Certificate in Mechanical Engineering. me previous experience of detailing and draughting chemical and allied plant desirable.—Apply in iting, giving full particulars of previous experience, alifications and age, to Personnel Department. E9301 A

RAUGHTSMEN required, fully experienced all es mechanical handling, for contract work— ply, giving full details, experience, &c., to The New veyor Company, Ltd., 9, Cork Street, London, 1. E9307 A

RAUGHTSMEN. Section Leader. Also senior d juniors ; preferably with experience of conveyors, dustrial ovens and furnaces.—Stordy Engineering mited, 85, Goldthorn Hill, Wolverhampton. E4124 A

RAWING-OFFICE CHECKER, for work on all electro-mechanical devices. Experience of nistry procedure an advantage. Pension scheme, .—Please apply, Louis Newmark, Ltd., Prefect orks, Purley Way, Croydon. E9197 A

OWIN DANKS & CO. (OLDBURY), LTD., dbury, nr. Birmingham.—Staff vacancies. One signing Draughtsman and Two Detailing Draughts- n required, experienced in the manufacture of el bunkers, general plate work, steel chimneys, cting, steel-frame buildings and structural work nerally. Salary commensurate with ability, inter- ing work, good conditions, canteen facilities, staff eranuation scheme. Permanent positions for t men.—Applications with full particulars to ief Engineer. E9242 A

LECTRICAL CONTRACTS ENGINEERS re- ired by Cooke and Ferguson, Limited, Switchgear ecialists, Manchester. Vacancies must be filled posts of section leader level on high-voltage con- cts work for the B.E.A. and overseas customers. pplicants must have Higher National Certificate d be able to control a section of the drawing-office. ary rates above association levels resulting from assessment scheme for applicants with the satis- tory qualifications.—Reply, stating experience and alifications, to Personnel Officer, South Street, enshaw, Manchester, 11. E4112 A

LECTRICAL ENGINEER, aged 30–40, prefer- ly chartered, required for leading position in design ice of London company manufacturing automatic cision machinery. Previous drawing-office and dustrial experience of control gear and mechanisms ential. Responsible progressive staff appointment ntributory pension scheme).—BOX No. E9246, The Engineer." A

NGINEER BUYERS AND REPRESENTA- VES' ASSOCIATION (Limited by Guarantee). e Council of this dominant professional organisa- n can fill vacancies for Engineer Buyers and gineer-Representatives (no fees—employers or mbers) and to consider applications for member- p from qualified Buyers and Representatives sociated with the Engineering and Allied Trades.— rite, E.B.R.A., 47, Victoria Street, London, S.W.1. L.: ABB 3583 (Employment Licence No. 6063.— censed annually by the L.C.C.). E627 A

ELECTRICAL ENGINEER for Sales. Midland Silicones, Ltd., an associated company of Albright and Wilson, Ltd., require a qualified Electrical Engineer as Assistant Manager of the Electrical Department in the London office. The duties comprise the marketing of silicones to the electrical industry, and provide great scope for the use of energy and initiative. Some travel is involved. H.N.C. in Electrical Engineering is a minimum qualification. Considerable experience in the use of insulating materials would be an advantage ; age 25–35. Good commencing salary and membership of non-contributory pension scheme.—Apply to the Appointments Officer, Albright and Wilson, Ltd, Oldbury, Birmingham. E9308 A

ELECTRICAL ENGINEER.—Simon-Carves, Ltd., have a vacancy in their Precipitator Division for an Electrical Engineer with at least five years' experience of contract and project work. H.N.C. is an essential qualification, while A.M.I.E.E. is desirable. The successful candidate will deal with technical correspondence, schemes, testing and fault location on site, and the supervision of electrical installation in connection with projects and contracts for electro-precipitators. Initial salary will depend upon age, experience, and qualifications. Working conditions and scope are excellent, and a pension scheme is in operation.—Apply in writing, quoting Ref. (MN36), to Staff and Training Division, Simon-Carves, Ltd., Cheadle Heath, Stockport. E9295 A

ENGINEER DRAUGHTSMAN for company specialising chemical engineering for fertilizer factories. Good technical and practical experience and fluent French desirable. Age about 30. Write age, experience and salary required.—BOX No. E4177, "The Engineer." A

ENGINEERING COMPANY of repute, with branch factories, Southern England, requires ASSISTANT CHIEF INSPECTOR, desirable age about 35, with sound practical experience of machine shop, fitting and assembly, who must be capable of administering the inspection function for high-precision manufacture from the standpoint both of quality control and man management. This, a responsible position which will be paid commensurately, carries early prospects of promotion with yet greater responsibility. Apply, giving brief but full particulars of personal and business history.—BOX No. E9260, "The Engineer." A

ENGINEERING DESIGNER, aged about 35 years, required with good mechanical and structural experience, for work on tender designs for crane and sluice installations. House available Ipswich or Felixstowe.—Apply, stating age, technical training and experience, to Secretary, Ransomes and Rapier, Ltd., Ipswich. E9316 A

ENGINEERING FIRM in West London requires the services of an Estimator with thorough knowledge of sheet metal fabricating and general machining. Experience with stainless steel would be an advantage. Progressive post for first-class man.—BOX No. E9298, "The Engineer." A

ENGINEER REPRESENTATIVE wanted, preferably with experience in asphalt quarrying and sand and gravel plant, covering mainly the South of England. Good prospects. Apply, stating experience and salary required.—BOX No. E4165, "The Engineer." A

ENGINEER required as Assistant to Machine Shop Manager for workshops of large factory, West London area. It is anticipated that the person selected will take full charge in due course. He should be aged between 26 and 36, be an Engineering Graduate or have equivalent proven qualifications. A wide variety of parts for maintenance and new process installations is handled, together with substantial production of steel and C.I. moulds to precision standards. Must be good disciplinarian, able and keen to operate within close cost margins. Attractive commencing salary with contributory pension scheme. Reply, stating full particulars in confidence. —BOX No. E9262, "The Engineer." A

ENGINEER required for a newly equipped vibration laboratory. Applicants should have graduated in either electrical or mechanical engineering and should have a knowledge of electronics. Previous experience of vibration and fatigue testing would be an advantage.—Please reply, stating qualifications, experience and age, to Personnel Manager, Joseph Lucas (Electrical), Ltd., Great King Street, Birmingham, 19. E9284 A

ENGINEER required, to take charge of all lubrication in large factory, West London area. Must have previous factory experience with technical approach to modern lubrication methods and able to supervise oiling personnel operating on three-shift basis. Knowledge of machinery, guards and safety procedure added recommendation. Good salary and contributory pension scheme. Write, stating age, qualification and positions held.—BOX No. E9263, "The Engineer." A

ENGINEER (SALES) required for works in Glasgow engaged in fabricated platework and structural work for oil, gas and chemical industries. Successful applicant would be required to travel, but could be resident in Glasgow. A.M.I.Mech.E. or equivalent qualifications would be an advantage. Salary would be appropriate to qualifications and experience. Pension scheme.—BOX No. E9229, "The Engineer."

ESTIMATING ENGINEER required, aged 25/30. Drawing-office experience essential, a knowledge of gas works engineering an advantage ; five-day week, pension scheme.—Apply in writing, giving details of age, experience and salary required, to Humphreys and Glasgow, Ltd., 22, Carlisle Place, S.W.1. E4168 A

ESTIMATOR.—Simon-Carves, Ltd., have a vacancy for an Estimator with experience of general chemical plant and structural work. Candidates must have some drawing-office experience. Salary according to age, experience and qualifications. Excellent working conditions and scope. A pension fund is in operation.—Apply in writing, quoting Ref. (MO40), to Staff and Training Division, Simon-Carves, Ltd., Cheadle Heath, Stockport. E9294 A

FOREMAN INSPECTOR is required by well-known auto. material manufacturer, capable of supervising the receiving inspection department, which controls intake of raw material and finished components, employing a staff of 75. Applicant must have served an apprenticeship. A knowledge of metrology, machining and foundry practice is essential. Pension scheme, including insurance. Apply, stating age and experience (in chronological order).—BOX No. E9286, "The Engineer." A

FOUNDRY ENGINEER.—Enthusiastic man required to develop plant and processes for new foundry techniques. Work involves initial experimentation, development of plant, and its use in the foundry. Some metallurgical and engineering knowledge is required, together with some experience of production problems. Initially the work will be concerned with the continuous casting of phosphor bronzes.—Please reply, giving details of experience and salary, to Director of Research, Rubery Owen and Co., Ltd., Booth Street, Darlaston. E9288 A

GRADUATE ENGINEERS seeking further industrial experience are required in connection with design development and research problems in the undermentioned divisions :—
Mechanical Engineering.
Civil Engineering.
Production Engineering.
Electrical Engineering.
Qualified applicants should possess a minimum amount of industrial experience and be within age groups 25–30. Locations : London, Bristol, Glasgow.
Write details qualifications, experience, salary, age to Messrs. Norris Industrial Consultants, Ltd., 3, Lexham Gardens, Cromwell Road, Kensington, London, W.8. E9063 A

IMPERIAL CHEMICAL INDUSTRIES, LTD., General Chemicals Division, requires an Electrical/Mechanical Engineer or Physicist for general process instrument work in the chemical industry in the North-West. Candidates should have an Honours Degree and some workshop experience in industry or in the Armed Services. Successful candidates will be appointed to the permanent staff with membership of the pension fund. Good prospects in a rapidly developing field exist for properly qualified individuals.—Apply, giving full particulars to the Staff Manager, Imperial Chemical Industries, Limited, General Chemicals Division, Cunard Building, Liverpool, 3. E8745 A

IMPERIAL CHEMICAL INDUSTRIES, LTD., Metals Division, requires a fully qualified young Electrical and Mechanical Engineer, capable of designing large-scale industrial power plant extensions. A good Engineering Degree, coupled with a keen interest in thermodynamic problems, will be an advantage.—Application forms may be obtained from Assistant Staff Manager, I.C.I. Metals Division, Kynoch Works, Witton, Birmingham, 6. E9287 A

INDIA
EXECUTIVE APPOINTMENTS

Director and General Manager of a large and well-established engineering works, South India, with manufacturing programme for automotive diesel engines, auto components, oil storage tanks, articulated trailer tanks, coach-building and general engineering, visiting England August, invites applications for :—

(1) PERSONAL ASSISTANT.—Qualified engineer, 35/45, of outstanding administrative and engineering ability with managerial experience, first-class knowledge of modern techniques of production and ability to handle personnel. Excellent opportunity for energetic person of high integrity with drive and personality.

(2) SALES MANAGER.—30/40, of proved ability in sales promotion and capable of controlling large sales and distributorship organisation for automotive diesel engines and other products throughout India. Only persons having held sales executive positions with first-class record will be considered.

(3) FOUNDRY MANAGER.—35/45, thoroughly experienced in the manufacture of automotive engine cylinder heads, blocks, manifolds and miscellaneous castings. Self-contained foundry with pattern shop will be erected and planned for producing 500 sets engine castings per month. Only first-class men having held similar position and capable of imparting training to labour will be considered.

Applications, in confidence, giving fullest details age, education, qualifications, experience, positions held and present salary in chronological order should be addressed to :—
Arthur J. Lund, M.I.Mech.E., M.I.P.E., A.M.Ae.S.I.,
C/o Wallace Cartwright and Co., Ltd.,
13, St. James's Square,
E9221 A London, S.W.1.

INSPECTING ENGINEER required by large concern in the North of England. Applicant must be experienced in industrial boiler plant and steam-raising equipment and possess good general engineering background. Commercial experience would also be an advantage. Applicant will be required to join superannuation scheme after probationary period. Apply, stating age, full details of experience and salary required.—BOX No. E9240, "The Engineer." A

INSTRUMENT ENGINEER required for large chemical factory in the Home Counties. Candidates should not exceed 35 years of age and should have sound theoretical training and practical experience in the installation and maintenance of industrial measuring and control instruments and, in addition, some knowledge of chemical works practice. Standard of education equivalent to Higher National Certificate is desirable. The position is one of permanency and a superannuation scheme is in force. Candidates should state age, details of training and experience.—BOX No. E9243, "The Engineer." A

INSTRUMENT MAKERS.—Interesting vacancies on mechanical and electronic development work. 44-hour week, social club, canteen.—Apply, Elliott Brothers (London), Limited, Borehamwood, Herts. E9254 A

INTERNAL COMBUSTION ENGINE research and development. Two Technical Assistants with knowledge of high-speed petrol and/or diesel engines. Minimum technical qualification H.N.C. Good conditions, reasonable prospects, pension facilities.—Apply, Personnel Manager, The Rover Co., Ltd., Acocks Green, Birmingham, 27. E4170 A

JOSEPH LUCAS, LIMITED, have vacancies for first-class Mechanical Engineers for the design and development of light hydraulic equipment. It is desirable that applicants should have a Degree in Mechanical Engineering with some practical experience, but consideration will be given to graduates without previous experience. The positions offer excellent opportunities for advancement and substantial salaries will be paid to the right men.—Please reply, stating qualifications, experience and age, to Personnel Manager, Joseph Lucas (Electrical), Limited, Great King Street, Birmingham, 19. E9283 A

JUNIOR DRAUGHTSMAN required, age 20–25, preferably with experience in design and layout of mechanical handling plant.—Write, stating age, experience and salary required, to British Industrial Sand, Ltd., Redhill, Surrey. E655 A

LARGE MANUFACTURING COMPANY has a vacancy for a qualified Mechanical Engineer, to advise factories within the group on material handling methods and increased mechanisation. Salary in accordance with experience and qualifications. Application should state age, previous engineering experience, together with indication of salary required.—BOX No. E9289, "The Engineer." A

LARGE MIDLAND FIRM requires first-class Engineer Designer with experience in high-pressure hydraulics, to work under direction of well-known consultant. The post is one of considerable responsibility. Letters, which will be treated with strict confidence, to be sent in the first place —BOX No. E4110, "The Engineer." A

MAINTENANCE ENGINEER required by confectionery firm in West London, fully experienced on bar wrapping and other types of confectionery wrapping machines. Commencing salary £600 per annum. —Apply, BOX No. 888, Dorland Advertising, Ltd., 18/20, Regent Street, S.W.1. E9253 A

MANAGER required for control of specialised engineering work at modern factory in the North-West. Previous experience required in operational planning, tool design, progressing and other functions of factory administration. Familiarity with group and individual piecework schemes for large and small batch production. Applications should state age, previous engineering experience and details of technical education, together with an indication of salary required.—BOX No. E9037, "The Engineer." A

MANAGERS required to develop sales and service in the Gold Coast and Nigeria of Marshall and Fowler tractors, and other construction equipment. Applications should be submitted in the first place to Personnel Manager, Marshall Sons and Company, Limited, Gainsborough, Lincs, indicating age, previous experience of construction plant, present employment and marital state. Successful applicants, after a period of training, will become members of the staff of the distributors, Messrs. John Holt and Company (Liverpool), Limited, and will be expected to work largely on their own initiative in developing a mechanical engineering department within the existing framework of John Holt's long-established widespread trading organisation. These are exceptional opportunities for young men prepared to work hard in these rapidly expanding countries, and offer considerable scope for advancement. Free overseas married quarters provided and liberal salary according to qualifications. E4175 A

MECHANICAL DRAUGHTSMEN wanted.—Write, stating age and experience, to Haskins, Gnome House, Blackhorse Lane, E.17. E652 A

MECHANICAL ENGINEERING ASSISTANT required in pump manufacturer's contract and estimating department in London.—Apply, Gwynnes Pumps, Ltd., 64, Chancellors Road, Hammersmith, W.6. E644 A

MECHANICAL ENGINEERING DRAUGHTSMAN required with general experience of medium and heavy work ; age 28/50. East Midlands area. Write, stating details of experience and salary required.—BOX No. E4144, "The Engineer." A

MECHANICAL ENGINEERING DRAUGHTSMAN required for large civil engineering and public works contractors. Permanent position at plant department in Cheshire.—BOX No. E4136, "The Engineer." A

MECHANICAL ENGINEER required in London quantity surveyor's office for examining schemes and accounts for heating, hot water, steam and air conditioning schemes, lifts, and all mechanical engineering works for building operations.—Apply, BOX No. 3, c/o Brown's, 37, Tothill Street, S.W.1, stating experience, qualifications and salary required. E9092 A

MECHANICAL ENGINEER required to assist on development work associated with internal combustion engines and their fuel and ignition systems. Applicants should have Degree or equivalent qualification, and it is desirable that they should have training in automobile engineering and engine testing. The work is varied and provides excellent opportunities for young engineers capable of giving original thought to new problems.—Please reply, stating age, qualifications and experience, to Personnel Manager, Joseph Lucas (Electrical), Ltd., Gt. King Street, Birmingham, quoting reference PM/D/9. E639 A

MECHANICAL ENGINEER with Degree or H.N.C. required for studies connected with the fuel and ignition equipment associated with boilers and small, land-based gas turbines. The position provides much interest and good prospects for advancement. Please reply, stating qualifications, experience and age, to Personnel Manager, Joseph Lucas, Ltd., Great King Street, Birmingham. E9205 A

MECHANICAL ENGINEERS with Degree and min. two years' industrial experience, invited to apply for position in design and development dept. of progressive petroleum and chemical plant designers. Sound knowledge of strength of materials required. Experience and knowledge of heat transfers an advantage for work on interesting new developments. Salary commensurate with qualifications. Excellent prospects of advancement for men of required calibre. Applications should be addressed.—BOX No. E9192, "The Engineer." A

MECHANICAL ENGINEER, University Graduate, age 25–45, required for establishment engaged on special process plant and machinery development. Must be able to carry out experimental work, solve unusual technical problems and present intelligent reports.—Apply in writing to Consultant Engineer, Ilford Limited, Romford, Essex. E4167 A

MONSANTO CHEMICALS, LIMITED, have vacancies for Junior Mechanical and Electrical Engineers at both the Newport and Ruabon factories. Applicants should hold a University Degree or equivalent qualifications and some experience is desirable but not essential. Graduates at present serving with the Forces are particularly invited to apply. The posts are permanent and pensionable and good salaries, according to training and experience, are offered.—Applications, giving details of age, education, training and experience, should be addressed to the Chief Personnel Officer, Monsanto Chemicals, Limited, 8, Waterloo Place, London, S.W.1. E9237 A

For continuation of Small Advts., page 6

SITUATIONS VACANT

NOTIFICATION OF VACANCIES ORDER, 1952.

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18–64 inclusive or a woman aged 18–59 inclusive, unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order, 1952.

MUNICIPAL MUTUAL INSURANCE, LIMITED, has vacancies for Engineer Surveyors. Posts are permanent and pensionable to satisfactory candidates, who should have served an apprenticeship and have sound practical and theoretical knowledge. Technical qualifications : First Class Ministry of Transport Certificate. Salary £540 to £785 per annum.—Apply in own handwriting, marking the envelope " Application, Engineer Surveyor," and " Private and confidential," to the Chief Engineer, 22, Old Queen Street, Westminster, S.W.1. E4157 A

ORR & BOSS AND PARTNERS, LTD., Industrial and Business Consultants, of 57, Victoria Street, London, S.W.1, invite applications for appointment to their staff from men of outstanding ability and personality who conform with the essential specification. Candidates should possess full academic and practical qualifications in engineering. Age 32 to 38. Progressive executive experience in several industries required. Full course of training in management consultancy will be given to successful candidates, normally at previous salary. Subsequently remuneration will progress to high level. After experience of consultancy work has been gained, prospects for selected men exceptionally attractive. E4114 A

PETER BROTHERHOOD, LTD., Peterborough require Draughtsmen (senior and junior), preferably with experience in design of compressors, turbines and steam engines. Permanent positions, five-day week, staff pension scheme.—Write, giving full details age, experience and salary required. E342 A

PLANNERS.—Large Engineering Company in South Midlands has vacancies for Junior Planning Engineers to prepare and maintain inspection operations sheets covering planned methods of measurement, gauging and visual inspection on a wide variety of components in light engineering. Positions are permanent and provide excellent opportunities for suitable men. Commencing salaries £10 to £11, according to age and experience. Attractive profit sharing and pension schemes. Applications giving full particulars.—BOX No. E9313, " The Engineer." A

PLANT DRAUGHTSMAN required for engineering works. Experience on workshop layouts and the application of modern handling methods essential. Good salary and permanent position for a man over 25 years of age, with suitable engineering background. Staff pension scheme. Canteen facilities.—Applications, which will be treated in the strictest confidence should state present position, salary and age, to the Works Manager, W. H. Allen, Sons and Co., Ltd. Queens Engineering Works, Bedford. E9302 A

PLANT ENGINEER (preferably University Graduate), to be responsible for the running and maintenance of all services including electricity generation (turbines and alternators), central heating (oil-fired), ventilation, &c., also production machinery, required for an interesting factory now being erected on outskirts of London. The successful applicant would be eligible for a permanent pensionable post at a starting salary of not less than £1200, depending on age, qualifications and experience. Upper age limit 45.—Write, stating age and giving details of education, qualifications and experience, to BOX P.908, c/o Streets, 110, Old Broad Street, E.C.2. E9238 A

PLANT MAINTENANCE ENGINEER required, to take full executive responsibility to the management for the proper maintenance of all plant and machinery associated with a new shipyard which is being equipped with modern cranes and steel fabrication plant. Salary will be paid according to qualifications, experience and ability. Applicants should state full details of their engineering training and subsequent career. Preference will be given to those with specialist knowledge to suit the duties required.—Applications should be addressed to the Deputy Chairman, Brooke Marine, Ltd., Harbour Road, Oulton Broad, Lowestoft, Suffolk. E4158 A

POTENTIAL EXECUTIVE (ENGINEER) required by leading combustion engineering company. The right man should be aged about 35, have had good basic engineering experience, a first-class education, be willing to learn and capable of being trained to director level. An initial salary of £1000 per annum is envisaged.—BOX No. E4140, " The Engineer." A

PRODUCTION DESIGN ENGINEER required. Essential to have good instrument design experience and practical knowledge of modern manufacturing facilities in precision engineering. Knowledge of hydraulics an advantage. Appropriate Degree or A.M.I.Mech.E. preferred.—Apply, with full details, including an indication of salary range, quoting No. 1483, to Personnel Manager, Sperry Gyroscope Co., Ltd., Great West Road, Brentford, Middx. E8985 A

PRODUCTION ENGINEER required by old-established engineers manufacturing wide range of specialist capital machinery. Initial appointment would be as Chief Planner. Candidates must be highly qualified in all branches of production engineering, i.e. process planning, rate fixing, time study, methods engineering and jig and tool design, and be accustomed to deal with job and batch production in the light of economy and efficiency of manufacture. For purposes of executive succession an age range of between 35 and 45 years is desirable. Conditions of employment accord with first-class modern practice. Applications, which will be treated in the strictest confidence and should give full details of age, education, training, experience and salaries earned, should be addressed to Production Director.—BOX No. E9127, " The Engineer." A

SENIOR AND JUNIOR DRAUGHTSMEN required for mechanical and by-product work in connection with coke ovens and gasworks plants. Some experience in allied work an advantage. Five-day week, canteen.—State age and details of experience to the Personnel Officer (D.O.), Woodall-Duckham Construction Company, Ltd., 63/77, Brompton Road, London, S.W.3. E9153 A

SENIOR DRAUGHTSMAN required by mechanical engineers, North-East London. Previous experience automatic bottling or canning plant an advantage. Progressive post for suitable man. Write, giving full particulars of past experience and salary required.—BOX No. E9136, " The Engineer." A

SITUATIONS VACANT

ROLLS-ROYCE OIL ENGINE DIVISION

require

JIG AND TOOL DRAUGHTSMEN.

Candidates must have had previous experience and workshop training. Excellent working conditions. Welfare facilities and pension scheme available.—Applications with fullest particulars of experience and qualifications should be sent to the Labour Manager (G), Rolls-Royce, Ltd., Derby. E9315 A

SENIOR DESIGN ENGINEER for position of responsibility required at once. Applicants should be accustomed to working on own initiative and should have wide experience in chemical plant engineering, iron and steel works plant, power distribution and general engineering services. Good salary will be paid to first-class engineer possessing undoubted experience, initiative and ability.—BOX No. E9291, " The Engineer." A

SENIOR DESIGNER required for work associated with the design and development of motor vehicle lighting equipment. Applicants should have experience in the design of pressed components and a knowledge of large quantity production methods is desirable. It is essential that they should be capable of carrying out original work and of initiating new designs.—Please reply, stating age, qualifications and experience, to Personnel Manager, Joseph Lucas (Electrical), Ltd., Gt. King Street, Birmingham, quoting reference PM/D/10. E640 A

SENIOR DESIGNERS & DEVELOPMENT ENGINEERS, with ingenuity and resource, required for work on pneumatic, hydraulic and electrical precision mechanisms, primarily for aircraft. Good salary, working conditions and pension scheme offered to engineers and physicists with Degree or H.N.C. preferably in Mechanical Engineering, and some experience in industry.—Please write to the Technical Manager, The Hymatic Engineering Co., Ltd., Redditch, Worcs. E9038 A

SENIOR DRAUGHTSMEN required for layout and detailing of conveyors and elevators. Some previous experience in this class of work essential. Good salaries paid for suitable applicants.—Apply, stating full particulars, to W. W. Brown and Partners, Ltd., 72, Newman Street, London, W.1. E4128 A

SENIOR ELECTRICAL FOREMAN required, to assist with the production of A.C. and D.C. electrical machinery. In addition to the necessary technical knowledge, applicants must have wide experience in the manufacture of A.C. and D.C. motors, generators and alternators. Permanent position with full staff status and pension rights.—Applications, which will be treated in the strictest confidence, should state full details of previous experience, age and present salary, to the Works Manager, W. H. Allen, Sons and Co., Ltd., Queens Engineering Works, Bedford. E9155 A

SENIOR ENGINEER required in Guided Weapons Division of the English Electric Co., Ltd., Luton, for work on computing devices. Engineers and physicists with a background of general electronics or light-current engineering would be suitable candidates. Design experience of feedback amplifiers or small servo-mechanisms a recommendation. Permanent position carrying an attractive salary for the right man. Staff pension after qualifying period.—Applications to Dept. C.P.S., 336/7, Strand, W.C.2, quoting Ref. S.A.23C. E9230 A

SENIOR ENGINEER required for post as Resident Engineer on large contract in Midlands. Experience in bridgework is necessary and knowledge of prestressed concrete an advantage. Apply, stating qualifications and experience.—BOX No. E4193, " The Engineer." A

SENIOR MECHANICAL DRAUGHTSMAN (Central London) with good practical and design experience. Preferably experienced on cardboard-box and carton making machinery. Full particulars of age, training, qualifications, experience and salary required.—BOX No. E4190, " The Engineer." A

SENIOR MECHANICAL DRAUGHTSMEN required, accustomed to heavy engineering work. Particular consideration will be given to applicants with experience in the following types of work :—

(a) Detail and design of rolling mills and ancillaries, either ferrous or non-ferrous.
(b) Works drawing-office procedure and the work carried out therein, preferably though not necessarily with experience in iron and steel works.
(c) Coal tar by-product plant works drawing-office work, covering detailing and installation of process plant and buildings, piping and other services.

Successful applicants will be expected to contribute to a superannuation fund. Nominal hours 38 per week, with payment for overtime. Apply, stating type of work (a), (b) or (c) required, with particulars of age, technical education, salary required, and when at liberty.—BOX No. E9279, " The Engineer." A

SHIFT CHEMISTS required by the Steel Company of Wales Limited (Steel Division), Port Talbot. Applicants should have experience in the routine analysis of iron and steel and should have completed their National Service or be exempt.—Those wishing to apply should send full particulars of age, experience, &c., to the Personnel Superintendent, The Steel Company of Wales Limited, P.O. Box No. 3, Port Talbot, Glam. E9206 A

SITUATIONS VACANT

SENIOR MECHANICAL DRAUGHTSMEN required, with knowledge of gear transmissions and agricultural equipment preferred, but not essential. Good conditions of work, pension scheme.—Applications, by letter only, to Clifford Aero and Auto, Ltd., Spring Road, Hall Green, Birmingham, 11. E4137 A

SPERRY GYROSCOPE COMPANY, LTD., invite applications from engineers holding a Degree or Membership of a Professional Institution for interesting research, design and development work on aircraft instrumentation, automatic controls, marine products, and guided missiles. Vacancies include :—

ELECTRO-MECHANICAL ENGINEERS, for Brentford and Feltham, also MECHANICAL ENGINEERS for Gloucestershire. Additional to above qualifications, desirable to have apprenticeship, knowledge of production methods, and experience in design of one or more of the following : gearing, instrument mechanisms, servos.

HYDRAULIC ENGINEERS, for Sunbury and Feltham. Must have experience of practical design and theoretical analysis of hydraulic systems. Knowledge of high-pressure hydraulics as applied to aircraft or hydraulic servo systems desirable.

ELECTRONIC ENGINEERS, for Brentford and Feltham. Additional to above qualifications, practical experience and knowledge of production methods, with experience in one or more of the following is desirable : control circuits, D.C. amplifiers, computing devices, video circuits.

Pension Scheme

Apply, giving full details, including an indication of the salary range and location preferred, to Personnel Manager, Sperry Gyroscope Co., Ltd., Great West Road, Brentford, Middx. E9015 A

STRUCTURAL DESIGN AND DETAILING DRAUGHTSMEN required by engineers for work in Bath or Weston-Super-Mare offices. Excellent working conditions, pension scheme and good salary. Holidays arranged this year can be taken. Apply with full particulars.—BOX No. E9228, " The Engineer." A

TECHNICAL ASSISTANT for interesting work in S.E. London on laboratory electrical and electronic instruments. G.C.E. Advanced Science or H.N.C. standard. Applicants with practical experience and National Service completed, or nearly so, please write, giving full particulars and salary required.—BOX No. E9305, " The Engineer." A

TECHNICAL ASSISTANTS required for experimental and engine research department of commercial vehicle manufacturers. Applicants should have Engineering Degree or equivalent and be capable of working with the minimum of supervision and be between the age of 28 to 30 years.—Applications in writing, stating age, experience, qualifications and salary required, to Staff Records Office, Windmill Lane, Southall, Middlesex. E9202 A

TECHNICAL ASSISTANT required in Patent Department of large engineering firm with offices in London. Candidates should possess a Degree, preferably in Engineering. Practical experience and a knowledge of German would be an advantage. Five-day week. Pension fund. Write in confidence, stating age, qualifications, experience, if any, and salary required.—BOX No. E9320, " The Engineer." A

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AVIATION DIVISION, COVENTRY.

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SENIOR DESIGN DRAUGHTSMEN

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Also

JUNIOR DETAIL DRAUGHTSMEN AND SENIOR AND JUNIOR STRESSMEN.

Experience of light hydraulic and pneumatic equipment would be advantageous.

The company's programme offers excellent prospects of permanent, interesting employment under congenial working conditions.

Salary will be commensurate with qualifications and experience.

Full details of which should be sent to :—

The LABOUR MANAGER,
DUNLOP RUBBER CO., LTD., AVIATION DIVISION,
FOLESHILL, COVENTRY.

E8701 A

THE ADVERTISERS, an old-established light electrical engineering firm, N.W. area, have immediate vacancies for Draughtsmen—Section Leaders, Seniors and Juniors—who have experience in (a) chassis and rack design, or (b) small electro-mechanical devices. All these posts are permanent and offer good prospects and attractive remuneration to those selected for appointment. Write, stating age, education, qualifications and experience, in confidence.—BOX No. E9222, " The Engineer." A

THE EXPRESS LIFT CO., LTD., wish to engage Draughtsmen for layout and design office, also Electrical Draughtsmen with experience in design of circuits and equipment. Applicants should be over 23 years of age and preferably have had experience in the lift industry.—Apply in writing to Personnel Manager, Abbey Works, Northampton. E4171 A

SITUATIONS VACANT

THE DISTILLERS COMPANY, LIMITED, require for their Engineering Division, London office, Senior and Junior Draughtsmen with experience in mechanical engineering, industrial and chemical plant layouts and detailing. The technical qualifications required are H.N.C. for senior and O.N.C. for Junior Draughtsmen.—Replies, stating fullest details of experience, qualifications, age and salary required, should be addressed to the Appointments Secretary, The Distillers Company, Limited, Engineering Division, Southern Office, Devonshire House, Piccadilly, London, W.1. E9047

THE ENGLISH ELECTRIC CO., LTD., require the following Engineers for new appointments in the Product Department at Stafford :—

(a) Product Development Engineers for development work on works study associated with manufacturing meters, relays and instruments and for work on high-quality electronic equipment.
(b) Product Engineers for switchgear and for light/medium electrical equipment, with detailed knowledge of sheet metal fabrication and welding for vacuum envelopes, with experience on electrical cubicle assembly and wiring.
(c) Works Layout Engineers with process and plant layout requirements experience, and Works Layout Draughtsmen.

With exception of draughtsmen, all applicants for above should possess at least O.N.C. and preferably H.N.C., with either Membership of Institution of Production Engineers or endorsements in production engineering. Additionally applicants should have served full-time apprenticeship and have experience on planning, rate fixing and jig and tool design. Apply, stating full particulars of experience and qualifications and quoting Ref. 1341, to Dept. C.P.S., 336/7, Strand, W.C.2. E9231

THE ENGLISH ELECTRIC COMPANY LIMITED

DRAUGHTSMEN

Additional Draughtsmen are required for a new works near Liverpool. The work is of an interesting nature, dealing with heavy mechanical equipment, and men conversant with heavy fabrication or rotating machinery are invited to apply. These are attractive positions with excellent opportunities for ambitious men. Houses may be available for suitable applicants.—Please write full details to Dept. C.P.S., 336/7, Strand, W.C.2, quoting Ref. 1295C. E9232 A

THE RIO DE JANEIRO TRAMWAY, LIGHT AND POWER CO., LTD., a British company in Brazil, invite applications from suitably qualified men for a post in Rio de Janeiro as Technical Assistant—Meter Division. Candidates should be between 25 and 30 years of age, and should have a University Degree or Higher National Certificate in Electrical Engineering, together with one to five years' experience in the meter department of a large utility manufacturer. Salary will be in accordance with qualifications and experience, taking into consideration local cost-of-living ; three years' agreement subject to renewal, with first-class passage both ways ; four months' leave on full pay after three years' service.—Written applications, which will be treated in confidence, should be made to Mr. W. Kellett, Joint Manager, Canadian-Brazilian Services Limited, 148, Leadenhall Street, London, E.C.3. Applications should be received by 31st July, 1954. E9219

TOOL ENGINEER, to be responsible for design and production of complete tools for office machines of entirely new design. Previous experience of tools for adding machines, typewriters or similar mechanisms essential and applicant to be fully conversant with modern mass production techniques. Good salary paid to man with right experience and ability. Reply with full details of previous experience, age and present salary.—BOX No. E4093, " The Engineer." A

TOOLROOM MANAGER required by manufacturers of domestic appliances. The successful applicant will control the manufacture of large and varied tooling projects, ranging from heavy press tools to precision small tools. Applications, which will be treated in strict confidence, are invited only from people with the highest qualifications and experience.—Please write, stating full personal details, to the Personnel Manager, The Davis Gas Stove Co., Ltd., Dallow Road, Luton. E4159

WANTED, SALESMAN with good connection amongst aircraft manufacturers and engineering firms. Admirable proposition for suitable applicant. Apply in confidence.—BOX No. E9132, " The Engineer." A

WANTED, SENIOR AND JUNIOR DRAUGHTSMEN, with experience in coal handling plants. Permanent positions offered with excellent salaries. Superannuation scheme in operation. Facilities being given to obtain housing accommodation for the senior posts.—Apply to The Norton Hartly Engineering Co., Ltd., Colliery and Structural Engineers, Great Bridge, Tipton, Staffs. E4196

WORKSHOP MANAGER required for our tractors plant reconditioning shops. Must be trained engineer with practical experience fuel pump repair, boring, sleeving, bearing work. Initiative and drive essential. Salary range, £800 to £1500, according to qualifications.—Fred Watkins (Boilers), Ltd., Coleford, Glos. E9184

WORKS MANAGER required, fully experienced for an old-established firm in the Midlands, for the welded tank, steel fabrication and press dept. State age and experience.—BOX No. E9299, " The Engineer." A

WORK STUDY ENGINEER.—Well-known light engineering company in a West London suburb requires man with good general engineering experience. Knowledge electro plating an advantage. Permanent post with superannuation. Five-day week. Apply giving details experience, age, salary required.—BOX No. E9281, " The Engineer." A

YOUNG MECHANICAL ENGINEERS required for design and development work on rocket motors in connection with the guided weapon programme. Duties will include the development of individual projects through all stages from preliminary design to production. Previous experience is not essential, but candidates should have a good Degree and preferably have some practical experience. Salary will depend upon age and qualifications and will be subject to annual increments. Assistance with housing. Replies to G.S.M., I.C.I., Ltd., Metals Division, Summerfield Research Station, Kidderminster, Worcs. E4151

For continuation of Small Advts., page

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The twenty-seventh Annual General Meeting of Imperial Chemical Industries Limited was held on June 17th in London.

Dr. Alexander Fleck, the chairman, presided and, in the course of his speech, said :—

The sales in 1953 were the highest in our history, and with new plants coming into operation we can confidently look forward to further increases in the years to come.

The net income of the Company for 1953 before appropriations for dividends and reserves was more than £17½ millions. The true profits for 1953 available for appropriation are really better than those of either 1951 or 1952.

CAPITAL PROGRAMME

The sums which have been provided for Depreciation, together with the £7 millions added to the Obsolescence and Replacement of Assets Reserve and the £6½ millions to the General Revenue Reserve, will all swell the Company's resources for its capital programme. This programme includes the replacement or modernization of existing plants as well as the erection of new plants to add to our productive capacity. The amounts which are thus provided from the Company's internal resources will not be sufficient to meet the whole of our capital requirements, and for this reason £30 millions of 4½ per cent Loan Stock was issued in March of this year. The response to the Issue was in the nature of an overwhelming vote of confidence in the Company by its Stockholders and the public generally. Although the amount to be issued, £30 millions, was the largest non-Governmental issue on record in London, applications were made for ten times this sum.

The Board's intentions, announced two years ago, of bringing the Ordinary share capital more into line with the true capital employed in the business by the capitalisation of reserves, can now be carried out.

DEVELOPMENTS

A substantial and increasing part of our capital programme is being devoted to the production of man-made fibres. Nylon polymer is produced by the Company, and while some part of this material goes into the manufacture of special products, the greater part is sold to British Nylon Spinners (in the capital of which your Company and Courtaulds have equal shares) to be spun into nylon yarn. The demand for nylon continues to rise, and plans for extensions, both in the manufacture of polymer and in its spinning by British Nylon Spinners, are under consideration.

PHARMACEUTICAL INDUSTRY

In the Annual Report reference is made to the attitude of the Ministry of Health towards the cost of pharmaceuticals required by the National Health Service. Any effort by a Government Department to cut down waste and extravagance is commendable. In this instance, however, there is the serious danger that a rather unintelligent application of quite inappropriate costing methods may damage or even destroy the most vital parts of the pharmaceuticals industry in this country. The danger is that pharmaceutical research may be rendered so unattractive in this country and so unprofitable that this important field of research may be abandoned by one Company after another, and this country may be forced to rely upon the scientific achievements of other countries. Research for new drugs is, and must remain, highly speculative ; only a small part of the research effort can ever be directly fruitful, but when success is achieved the cost of all the work which has proved fruitless for its original purpose must be taken into account. The profit on the successful discovery must cover the cost of the unsuccessful research if any concern is to be encouraged to carry on this speculative but valuable work. Even the successful product may hold the field for a short time only and be replaced by some other product discovered either in this country or overseas. Costing principles permitting a very limited percentage of profit on the manufacturing cost of a commodity may no doubt be appropriate and proper in some cases, but I suggest that in the case of drugs which it is decided to produce and which the National Health Service wants, the rigid and unimaginative application of such principles will lead to results that are unfair to the industry. I would again emphasize that the true cost of the drug includes, as well as the other overhead expenditure, the cost of much patient scientific effort spread over many years and many possible products. I regard this danger, that is the application of inappropriate costing methods to an important section of industrial scientific research in this country, as serious ; and I trust that in this matter greater wisdom will prevail.

NATIONALIZATION

The Board remain as firmly as ever opposed to every form of nationalization of the Company. They keep this subject of the danger of nationalization under constant consideration and will continue to do so even though the danger may from time to time appear to recede.

PROFIT SHARING SCHEME

The references in the Report and in the Press to the proposed Profit Sharing Scheme for employees will not have escaped your notice. This matter has been under consideration for a long time, and the Scheme which the Board now propose to introduce is the result of prolonged and earnest thought on the subject.

Any scheme which gave employees a cash sum regularly each year would suffer from the disadvantage that the receipt of the sum would become a normal expectation and would lose the character of profit sharing. If for any reason the amount had to be reduced or withheld altogether, there would be widespread comments among employees probably suggesting hardship. At the same time, any scheme which distributed each year very large numbers of exceedingly small holdings in the Company would be unsatisfactory and difficult to administer. The Board believe that the Scheme proposed, which puts the net bonus to the credit of the employee in the accounts of Trustees appointed for the purpose, and provides for the issue of a Stock Certificate to the employee himself only when the account reaches a reasonable figure, is more likely to induce employees to retain their holdings of Stock than one in which the shares were issued each year direct to the employees.

The Board do not believe that the existence of the Scheme will have a direct effect upon the amount of work done or the productivity of individual workers ; that is not its purpose. There are other means of encouraging hard work and good work, including the scientific application of Work Study (including Method Study), a field in which this Company plays a leading part. The Scheme does, however, serve a purpose which, though less tangible, is no less important. In the long run the health of the Company's economy depends upon the whole-hearted co-operation of workers, management, Stockholders and customers. The part played by each element in our complicated economy is very imperfectly understood, and misunderstandings can cause deep-rooted malaise which can undermine the country's economic health and stability. We believe that the Scheme which we propose to introduce will play a useful part in bringing management, factory payroll and Stockholders together and in spreading a better understanding of our mutual interests.

The Scheme provides for an increase in the bonus if dividends are increased. Stockholders and employees will thus both share in any increased prosperity which it may be our good fortune to enjoy in future years. They will also have some share in any adversity which we may suffer.

The capital structure of the Company is the subject of resolutions to be submitted at special meetings which will follow this meeting, and the proposed Profit Sharing Scheme will be based upon the new capital figures which the Board hope will result from the acceptance of those resolutions. We cannot foretell what changes may take place in the Company's capital structure and other circumstances in years to come, and for that reason the Profit Sharing Scheme will remain subject to the control of the Board. Bonuses under the Scheme are in no way part of the terms and conditions of employment and are not intended to be a substitute for fair wages and conditions. If on experience it is found that the scheme requires modification, the Board will not hesitate to make the necessary changes, but it is hoped that any modifications to the Scheme will be of a minor character only, because much of the value of the Scheme would be lost if substantial changes had to be made at frequent intervals.

THE OUTLOOK

You will expect me to say something about our course of business so far in 1954, and our prospects for the future. So far this year the Company has enjoyed, in common with other industries in this country, a period of expansion, and the prospects are in general good. In overseas markets competition is strong, but we believe that we can hold our own and in some directions gain further ground. Neither at home nor overseas can there be any easing-up, but with competent, loyal and energetic personnel throughout the whole organisation, we have every reason to believe that difficulties will be overcome and further progress made both this year and in years to come, when much of the present capital expenditure will be completed and will give us additional productive capacity.

The report and accounts were adopted.

The proposals for capitalisation of Reserves and Scrip Issues were duly approved at the Extraordinary and Class Meetings subsequently held. Renounceable allotment letters will be despatched to Preference and Ordinary Stockholders on Friday, 16th July, 1954.

SITUATIONS WANTED

CHARTERED ACCOUNTANT (young), previously four years aeronautical engineering, having now obtained several years' commercial experience, requires position as Assistant to Managing Director of large engineering/metallurgical company, where energy and ability will be utilised and rewarded. Salary about £1500.—BOX No. E4197, "The Engineer." B

DEVELOPMENT ENGINEER (34), with experience in mechanical and chemical engineering, seeks a post as Technical Assistant, Assistant Engineer or a similar responsible position in Bristol.—BOX No. E4199, "The Engineer." B

MARINE ENGINEER (27), First Class M.O.T. Certificate, higher technical education, desires position ashore with firm which will lead to his return to New Zealand.—BOX No. E4183, "The Engineer." B

MECHANICAL ENGINEER, age 28, public school, B.Sc. (Eng.) Hons., A.C.G.I., G.I.Mech.E., with seven years' experience in development and production, seeks appointment as Personal Assistant to Senior Executive or similar progressive position. Salary required £950 p.a.—BOX No. E4184, "The Engineer." B

MECHANICAL ENGINEER (36), A.M.I.Mech.E. Experience: installation, maintenance and development of light, medium and heavy engineering plant, including H.P. hydraulics, air compressors and all factory services; plant layouts; special machine design, &c. Hard working, adaptable. Requires interesting post with prospects in London or Home Counties area.—BOX No. E4131, "The Engineer." B

PRODUCTION ENGINEER (36), qual. 22 years exp., jigs and tools, planning, design, admin. organisation, specialist tungsten carbide tooling. Chief planning engineer two years, tech. representation, seeks new post. Executives invited to write in confidence.—BOX No. E4185, "The Engineer." B

AGENCIES

ACTIVE REPRESENTATION.—Engineers, having thorough commercial experience, contacts all levels, mainly London and South, also principal Northern areas, seek manufacturers interested Agency agreement, steel fabrications and pipework for all industries, including petroleum, chemical, Government depts.—BOX No. E4182, "The Engineer." D

AGENCY REQUIRED by Engineers' Draughtsman, covering pipes, valves, &c. London and/or Home Counties. London office and telephone facilities available.—BOX No. E4191, "The Engineer." D

MECHANICAL ENGINEER, M.Inst.B.E., London office, established seven years agent and consultant, previous southern area manager, well-known industrial group, chief draughtsman, material handling and automatic weighing, locomotive training, wishes to act for substantial firm general plant and/or equipment or top-grade speciality, commission basis.—BOX No. E4186, "The Engineer." D

PAINT MANUFACTURERS require additional Agents to call on engineers, &c., to sell full range of paints at highly competitive prices. Worthwhile commission to enterprising salesmen. State area covered and lines carried.—J. Johnstone and Sons, Limited, Paint Manufacturers, High Street, Gorton, Manchester. E8950 D

BUSINESS OPPORTUNITIES

INVENTOR of domestic electric washing machine, based on entirely new principle, wishes to Contact Manufacturer prepared to undertake development work.—BOX No. E4188, "The Engineer." O

PIPE AND ENGINEERING INSPECTION SPECIALISTS, 50 years' personal British and Continental service to civil and gas engineers.—B. Taylor and Son, 25, St. James's Chambers, St. James's Street, Derby. E4004 O

PRIVATE INVESTMENT TRUST wishes to increase its holding in sound industrial private companies, with good profit records and scope for development. Acquisition of controlling interest in firms of approx. £100,000 value envisaged. Suitable opportunity for those who wish to realise funds, but who wish to continue in business. Generous service contracts will be offered to essential management personnel.—Reply, giving brief particulars, which will be treated in strictest confidence, to BOX JN/117, c/o 95, Bishopsgate, E.C.2. E9268 O

MISCELLANEOUS

CORNEAL AND CONTACT LENSES. Invisible aids to better vision. Easy payments arranged.—For details and booklet write David Blackstone, Ltd., Dept. 238, Triumph House, 189 Regent Street, London, W.1. Consulting rooms in most main centres. E9234 I

WE CAN OFFER ALL TYPES OF TEXTILES, Grey Cloths, Industrial and Protective Clothing, Cleaning Rags, &c., also a quantity of 24V D.C. Dynamos.—Please send inquiries to Surplus Textiles, 32a, Booth Street, Manchester, 2 (Cen. 2849 and 5547). E9133 I

SPANISH, PORTUGUESE AND FRENCH Technical and Scientific Translations.—J. L. Castillo, M.A. (Cantab.) (HAM 5669). E4198 I

BUSINESSES and PREMISES

BUILDINGS For Sale.—Prefabricated factories, stores, workshops, canteens, offices, halls, clubs, garages, &c., large and small.—Apply for details and prices, stating your requirements, to J. Thorn and Sons, Ltd., BOX 37, Brampton Road, Bexleyheath, Kent. (Tel., Bexleyheath 305). E416 L

PREMISES WANTED, Small Engineering Works, 4000 to 10,000 sq. ft., in London area, preferably equipped with machine tools.—BOX No. E9233, "The Engineer." L

PRINCE'S GATE, KENSINGTON, S.W.7 (in the City of Westminster), entire Office Building, 5340 sq. ft.; 22 rooms, including one of 700 sq. ft. Completely redecorated throughout. Rental £2750 p.a. No premium.—Moss and Partners, 15, South Molton Street, W.1 (MAYfair 9933/7). E9194 L

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ACCURATE MACHINING

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From ounces up to 1 Ton.

MILLING TURNING
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GIVE US YOUR DIFFICULT JOBS.

LANDEN (ENGINEERS) LTD.,
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CANonbury 1075.
E630 MW

CASTINGS.—We can save your porous castings, ferrous or non-ferrous, by an approved impregnation process; sample castings treated; A.I.D. approved.—Recupero, Ltd., 66, South Harrow Viaduct, Harrow, Middlesex ('Phone, Byron 1178). E575 MW

CYLINDRICAL AND SURFACE GRINDING. Turning up to 42in. dia., milling up to 72in. by 24in. Planing up to 72in. by 36in. Metal stamping up to 100 tons. Diecasting up to 5½ lb. Zinc Base Plating. Stove Enamelling. Assembly and Experimental Work undertaken. A.I.D. approved. Jigs, Gauges, Fixtures, Mould and Press Tool Makers, Precision Engineers.

B.K. ENGINEERING CO.,
17, Clifford Road, S.E.25.
ADDiscombe 4744, 2174, 3592. E624 MW

FAIRMAN PRECISION TOOLS and Products, Ltd., of Horley, Surrey, manufactures Plastic Moulds, Jigs and Fixtures, Press Tools, Special-Purpose Machines, &c.—'Phone Horley 3678. E619 MW

FREE LANCE.—Designer-Draughtsman (47), 30 years' general mechanical, hydraulic and pneumatic experience, would like to Extend existing Connections with manufacturers, inventors, &c. Can assist firms who are temporarily overloaded in design department.—BOX No. E4187, "The Engineer." MW

KELLERING AND PROFILE MILLING in all metals. Send us your die blocks to copy from wood or plaster masters. Up to 5ft. by 8ft. max. size. We are die copiers to the trade.—Armytage Bros. (Knottingley), Ltd., The Foundry, Knottingley, Yorkshire (Tel., Knottingley 46). E540 MW

PRECISION ENGINEERS.—Personal service for prototypes, small quantity machined parts and equipments. Design undertaken. A.I.D. Approved Mech. and Elect.—Cathanode, Limited, Vineyard Walk, Clerkenwell, E.C.1 ('Phone, TERminus 5113-4). E650 MW

TUBE BENDING SERVICE offered for ferrous and non-ferrous tubes up to 4in. N.B. Keen quotations given upon receipt of full details.—BOX No. E641, "The Engineer." MW

FOR HIRE

LATTICE STEEL Erection Masts (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, Terminal House, London, S.W.1 ('Phone, SLOane 5259). E112 K

NEW 3-TON CAPACITY MOBILE CRANE, taxed for use on roads.—Details of rates from J.F., "Pinewood," Pine Grove, Brookmans Park, Herts. E9245 K

MACHINERY Etc. WANTED

GALVANISED CORRUGATED STEEL SHEETS required, new, 22 and 24 gauge, 6ft. to 12ft. long, approx.; 50 tons required.—Offers to Bellman Hangars, Ltd., Terminal House, S.W.1. E9186 F

LORAIN MC3 Lorry-Mounted Crane, excavating equipment, particularly trencher. Full Details.—BOX No. E9248, "The Engineer." F

WANTED, all types of modern motorised Machine Tools. Offer your surplus to us and obtain the best prices.—Norman E. Potts (Birmingham), Ltd., 105, Alcester Road South, Birmingham, 14. E123 F

WANTED, AS LYING ON SITE, horizontal single and double cylinder hot or cold start Oil Engines, also old Hornsby Paraffin Engines, blow-lamp start.—Hopkins, Engineers, Frampton Cotterell, Bristol. E4062 F

WANTED, good modern Steam-Raising Boilers, Water-Tube, Lancashire, Economic and Vertical types.—Please send full details to George Cohen, Sons and Co., Ltd., Wood Lane, London, W.12 (Tel.: Shepherds Bush 2070), and Stanningley, Nr. Leeds (Tel.: Pudsey 2241). E9236 F

WANTED, Guillotine Shears, ¼in. by 8ft., motorised 440/3/50.—BOX No. E9030, "The Engineer." F

WANTED, 2-ton Overhead Travelling Crane, floor controlled, 400/3/50, 38ft. span.—BOX No. E9031, "The Engineer." F

WANTED, 250 c. ft. stationary Air Compressor, 100 p.s.i., motorised 440/3/50.—BOX No. E9029, "The Engineer." F

20-TON ROAD WEIGHBRIDGE, 20ft. by 8ft. preferred.—Replies to British Industrial Sand, Ltd., Redhill, Surrey. E4194 F

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DIMCO

PLANER

3ft. 6in. by 3ft. 6in. by 10ft. Stirk Velopiane, fitted with two heads on cross rail and one side head, table speeds variable from 30 to 90ft. per minute, pendant control complete with Stirk patent drive for 400/440/3/50.

Machine can be inspected running.

DIMCO (GT. BRITAIN) LIMITED,
415–417, OXFORD STREET,
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Telephone No.: MAYfair 1585–6–7.
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CONNELL
OF COATBRIDGE

OFFER THE FOLLOWING BOILERS FOR DISPOSAL EX STOCK:—

WATER TUBE

Babcock and Wilcox Water Tube Boiler, steel cased type, self-contained, working pressure 250 lb., evaporation at least 22,000 lb. per hour, practically unused. Year 1944.

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Paxman, Horizontal, Economic, Multitubular Boiler, 14ft. long by 6ft. 7in. dia. by 160 lb. working pressure, evaporation approximately 7890 lb. per hour from feed at 212 deg. F.

LANCASHIRE

One 24ft. long by 9ft. dia. by 190 lb. working pressure, hand fired.

One 21ft. long by 7ft. 6in. dia. by 100 lb. working pressure, hand fired.

VERTICAL

Blake, Vertical, Multitubular, coal fired, 17ft. 6in. high by 7ft. dia. by 160 lb. working pressure, evaporation approximately 3000 lb. per hour.

Cochrane No. 10, Vertical, Multitubular, coal fired, 12ft. 3in. high by 5ft. 6in. dia. by 100 lb. working pressure, evaporation approximately 1620 lb. per hour.

Vertical, coal fired, Cross Tube, 12ft. by 6ft. by 100 lb. working pressure

Cochrane No. 9, Vertical, Multitubular, coal fired, 11ft. 9in. high by 5ft. 3in. dia. by 100 lb. working pressure, evaporation approximately 1320 lb. per hour.

Vertical, coal fired, cross tube, 11ft. by 3ft. 9in. by 100 lb. working pressure.

Vertical, coal fired, cross tube, 10ft. by 4ft. 6in. by 100 lb. working pressure.

Vertical, coal fired, cross tube, 10ft. by 4ft. by 100 lb working pressure.

Vertical, coal fired, thimble tube, 8ft. by 3ft. 9in. by 80 lb. working pressure.

Vertical, coal fired, cross tube, 7ft. 6in. by 4ft. by 100 lb. working pressure.

Vertical, coal fired, cross tube, 7ft. 6in. by 3ft. 3in. by 100 lb. working pressure.

Vertical, coal fired, cross tube, 7ft. by 3ft. 3in. by 100 lb. working pressure.

Cochrane, vertical, coal or gas fired, hot water Boiler, 6ft. by 3ft.

Scottish agents for Riley Boilers and pressure vessels.

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600

NEW ELECTRICALLY-DRIVEN PUMPS

1000 g.p.m., 50ft. hd., 6in. AR. Pump by TANGYE, mounted on bed-plate and direct coupled to Brook 25 h.p. S/R. motor, 400/440/3/50, 1500 r.p.m.

Three 1162 g.p.m., 113 ft. hd., SNB6 (360m.m. impeller) Pumps by HARLAND, mounted on bed-plate and direct coupled to Brook 60 h.p. S/R. motor, 400/440/3/50, 1500 r.p.m.

Three 658 g.p.m., 69ft. hd., SNB5 (300m.m. impeller) Pumps by HARLAND, mounted on bed-plate and direct coupled to Brook 25 h.p. S/R. motor, 400/440/3/50, 1500 r.p.m.

Two 750 g.p.m., 52ft. hd., 5in. AR. Pumps by TANGYE, mounted on bed-plate and direct coupled to Brook 20 h.p. S/R. motor, 400/440/3/50, 1500 r.p.m.

Two 232 g.p.m., 60ft. hd., SNB4 (240m.m. impeller) Pumps by HARLAND, mounted on bed-plate and direct coupled to Brook 10 h.p. squirrel-cage motor, 400/440/3/50, 1500 r.p.m.

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DIESEL ENGINES

56/60 H.P. PETTERS VICKERS, 2-cylinder vertical, 325 r.p.m.

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NEW 15 H.P. LISTER FR2, 2-cylinder vertical, radiator cooled.

14 H.P. LISTER 14 CE, 2-cylinder vertical.

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9 H.P. LISTER 9/1, single-cylinder vertical.

NEW 5 H.P. PETTERS AVA1, air cooled, 750/1500 r.p.m.

LISTER 3½ H.P., single-cylinder vertical, 650 r.p.m.

NEW 1½/2½ H.P. PETTERS PAZ1, air cooled, 750/1500 r.p.m.

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NEW and SECOND-HAND by LISTER, PETTERS, VILLIERS, &c. Villiers main service and spares agents. Exchange engines in stock.

WILLIAM R. SELWOOD LTD.,
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MONARCH Centre Lathe, 30in. swing by 28ft. B.C., S.S and S.C., straight bed, twin saddles, each fitted taper turning. Travelling and fixed steadies. Motorised.

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(VIC 1278.) E9264 G

See our advertisement on page 143

HOBSON 5½in. Lathes from £120. EAGLE SURFACE GRINDERS, 15in. by 6in., at £140.—Victa Engineering Co., Maidenhead ('Phone, 50). E4154 G

FOR SALE

ADAMS

HEAVY DUTY
MACHINE TOOLS

OFFERED FROM STOCK!

VERTICAL BORERS

SONDERMANN and STIER 34in., single colu... motor drive, table dia. 31½in., max. swing 33... working height 29½in., 12 speeds 2·3–70 r.p.m.

BULLARD 36in. "Spiral Drive" New Era mo... motor drive, single column, table dia. 34in., m... swing 38in., working height 25in., 12 spe... 4·6–77 r.p.m.

RICHARDS 36in., double column, motor dr... two swivel toolheads and pentagon side to... holder, table dia. 34in., max. swing 36in., work... height 30in., 12 speeds 1·88–45 r.p.m.

RICHARDS 48in., double column, motor dr... two swivel toolheads, table dia. 44in., max. sw... 48in., working height 44in., 12 speeds 1·48–3... r.p.m.

RICHARDS 72in., double column, motor dri... two swivel toolheads, table dia. 65in., max. sw... 72in., height admitted 44in., 12 speeds 1·49–3... r.p.m.

HORIZONTAL BORERS

GILLY Model AFMF.70, motor drive, spin... dia. 2¾in., facing capacity 21½in., rotary ta... 39¾in. by 31½in., speed range 7–950 r.p.m.

KEARNS No. 2, patent type, motor drive, spin... dia. 3in., facing capacity 30in., main table 48... by 30in., top table 36in. by 36in., speed ra... 3·1–250 r.p.m.

SCHARMANN Model HBSF2, motor drive, spin... dia. 3in., facing capacity 29½in., rotary table 31... by 39½in., speed range 5·9–1180 r.p.m.

KEARNS No. 5, patent type, motor drive, spin... dia. 5in., facing capacity 54in., main table 84in.... 48in., top table 60in. by 60in., speed range 2–1... r.p.m.

PEARNS RICHARDS No. 5, motor drive, out... stay, quartering table, screwcutting attachme... facing capacity 48in., main table 87in. by 48i... rotary table 48in. by 48in., length of bed from fa... of upright 11ft. 6in., 32 speeds 15–160 r.p.m.

PLANERS

CINCINNATI 36in., motor drive, vertically adjus... able cross rail with one toolbox, horizontal a... vertical power feeds, max. stroke 36in., ta... surface 63in. by 17½in., max. distance under cr... rail 14½in., 6 table speeds 6–43ft. p.m.

SWIFT-SUMMERSKILL 6ft. by 2ft. by 2ft., doub... column, motor drive, through three-speed gearbo... one toolbox on cross rail, planing length 6ft., wid... 2ft., height 2ft., table surface 6ft. by 1ft. 8in.

STIRK 6ft. by 2ft. 6in. by 2ft. 6in., double colum... motor drive, one toolbox on cross rail and o... sidehead, planing length 6ft., width 2ft. 6... height 2ft. 6in., table surface 6ft. by 2ft. 4in.

LOUDON 6ft. by 3ft. by 3ft., double column, mo... drive with generating set, two toolheads on cr... rail and one sidehead, planing length 6ft., betwe... uprights 44in., approx. working height 45in.

REDMAN 8ft. by 3ft. by 3ft., double column, b... drive, two toolheads on cross rail, planing leng... 8ft., width 3ft., height 3ft., width of table 2ft. 8i... cutting speed 30ft. p.m., return speed 120ft. p.... This machine can easily be converted to dir... motor drive, for which our CARLUT PLANE... CONVERSION UNIT is recommended.

SWIFT-SUMMERSKILL 8ft. by 4ft. by 4ft. ... double column, Model 48H, all-electric motor dri... two toolheads on cross rail and one sidehead... planing length 8ft., between uprights 4ft., worki... height 4ft.; table width 3ft. 8in., cutting spee... 25–200ft. p.m.

STIRK 24ft. by 7ft. 3in. by 5ft. "Hiloplane" ... double column, with tandem tables, Stirk spi... field driving set (variant of the Ward Leonar... system), 4 toolboxes, 2 on cross rail and 1 on ea... upright, all fitted with Solenoid lifting device pr... viding tool relief on return stroke, planing leng... 24ft., planing width 7ft. 3in., planing height 5ft... length of bed 43ft., length of front table 14ft. 9in... length of rear table 10ft. 9in., width of tab... 5ft. 10in.

SOAG MACHINE TOOLS LIMITED
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'Phone: Reliance 3373.
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E210 G

600

DIESEL ENGINES

110 h.p. PETTER "Atomic," vert., 4 cyl., 2 stroke... air starting, 450 r.p.m.

104 h.p. CROSSLEY FOE4, horiz., 4 cyl., 4 stroke... air starting, 400 r.p.m.

100/120 b.h.p. PETTER SS2, vert., twin cyl., 2 stroke... air starting, 400/500 r.p.m.

72 h.p. PETTER "Atomic," vert., twin cyl., 2 stroke... air starting, 500 r.p.m.

60 h.p. FIELDING and PLATT, vert., twin cyl... 4 stroke, air starting, 400 r.p.m.

Two 55 h.p. PETTER "Atomic," vert., twin cyl... 2 stroke, air starting, 450 r.p.m.

All complete with standard accessories, shaft exten... sion and outer bearings.

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Tel.: Shepherds Bush 2070; and
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B.C.S.

One 100kW Blackstone/Crompton Parkinson 400/440-3-50, 500 r.p.m., auxiliaries, &c.

Two 20kW Hill and Company/Delco 120 volt D.C., 167 amps., 1450 r.p.m., auxiliaries, &c.

Three 14kW Coventry Climax/McLure and Whitfield, 230 volt D.C., 52 amps., 1750 r.p.m., auxiliaries, unused.

Other sets in stock.

3, CASTLE STREET, CARDIFF.
Tel.: Cardiff 29246. E9170 G

Classified Advertisements are continued on page 145

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Cooper McDougall & Robertson Ltd.
James Pascall Ltd.
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Clover Dairies Ltd.
International Model Aircraft Ltd.
Kings Cross Laundry Ltd.
Samuel Booth & Co. Ltd.
National Benzole Co. Ltd.
Vandervell Products Ltd.
British Tabulating Machine Co. Ltd.
Fibreglass Ltd.
Rolls-Royce Ltd.
Bray Brass Foundry Co. Ltd.
C.A.V. Ltd.
Optrex Ltd.
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Gillette Industries Ltd.
Henley Tyre & Rubber Co. Ltd.
British Sugar Corporation
Laurence Scott & Electromotors Ltd.
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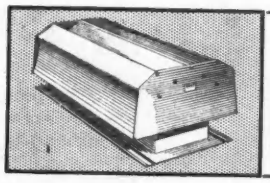

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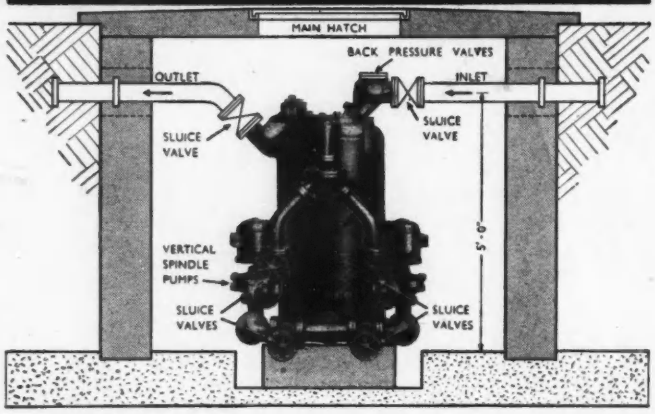

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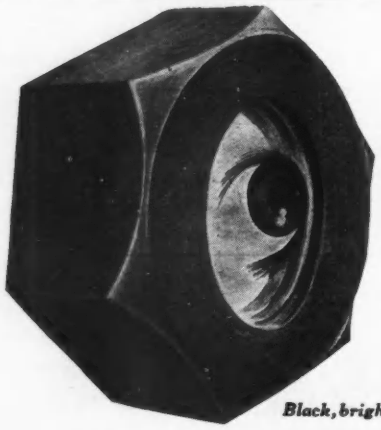

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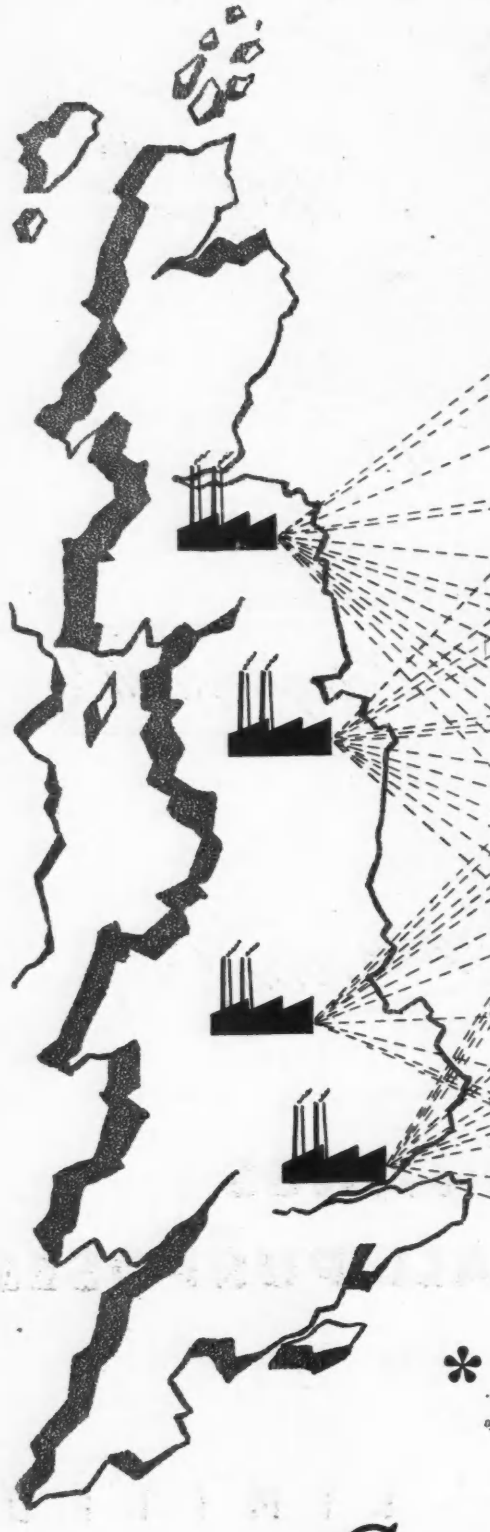

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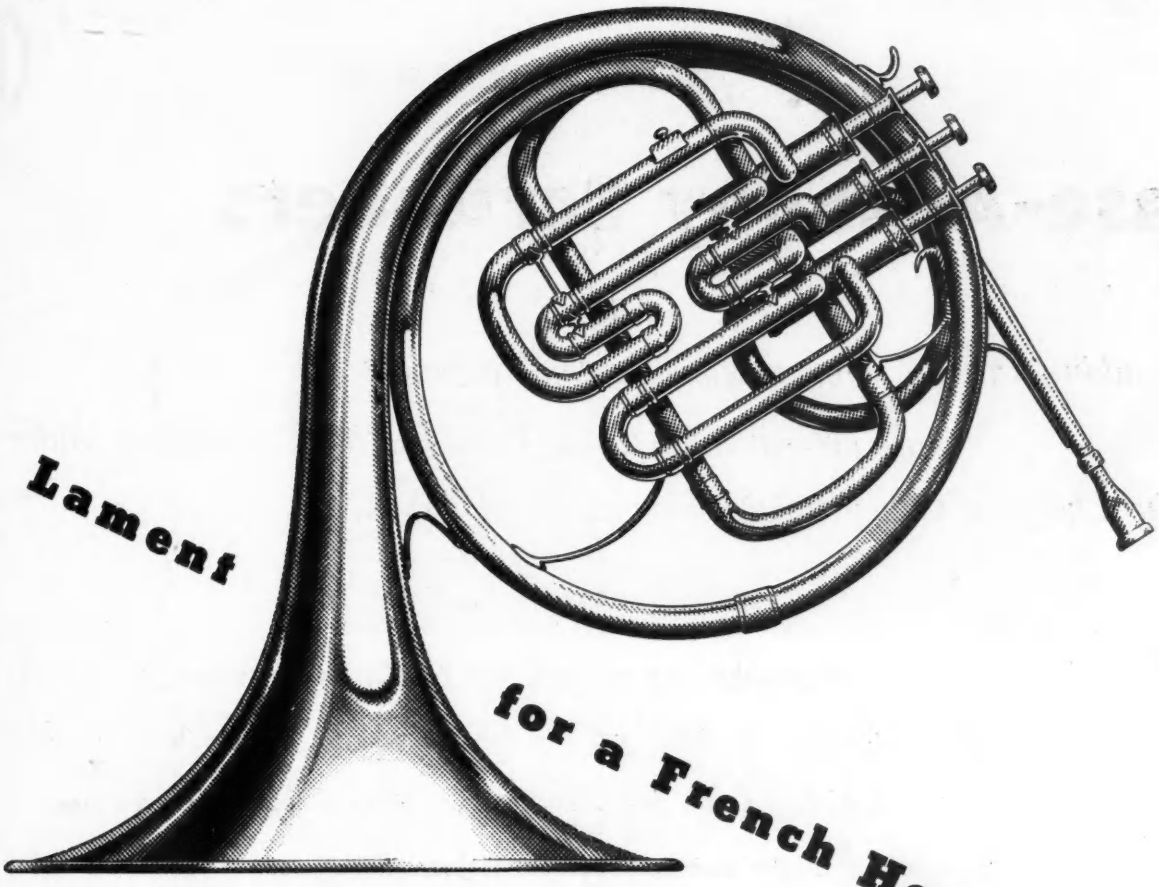

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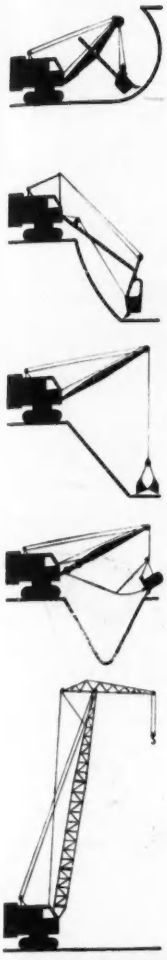

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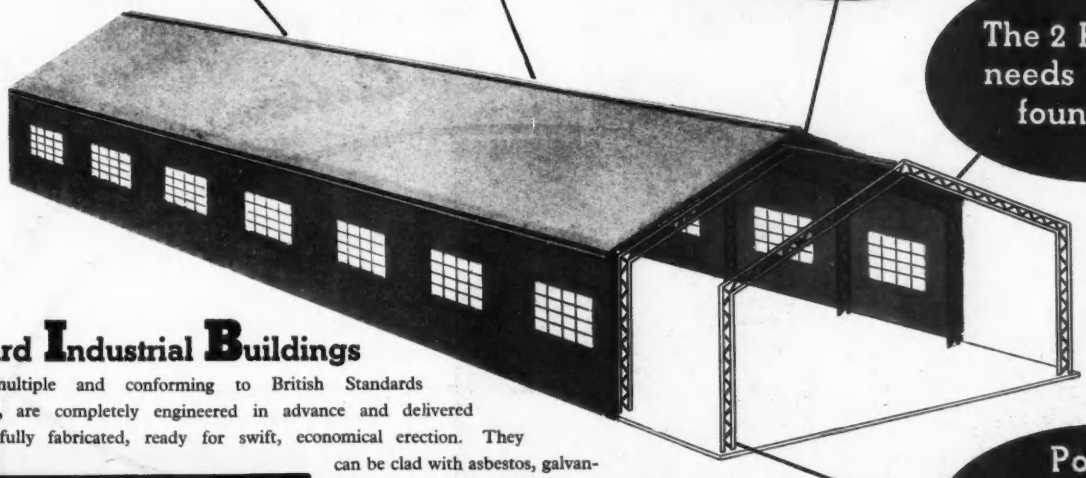

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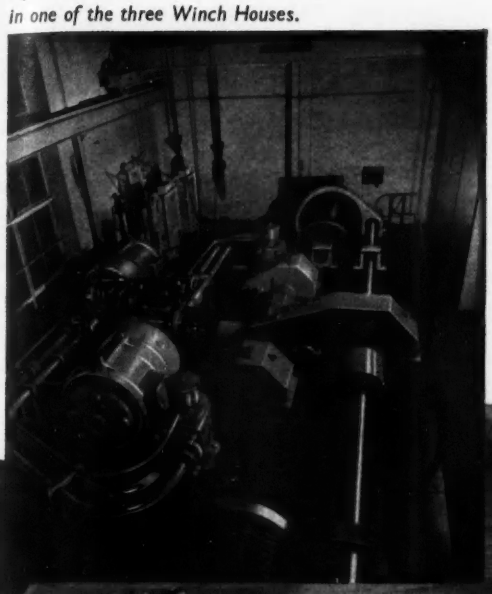

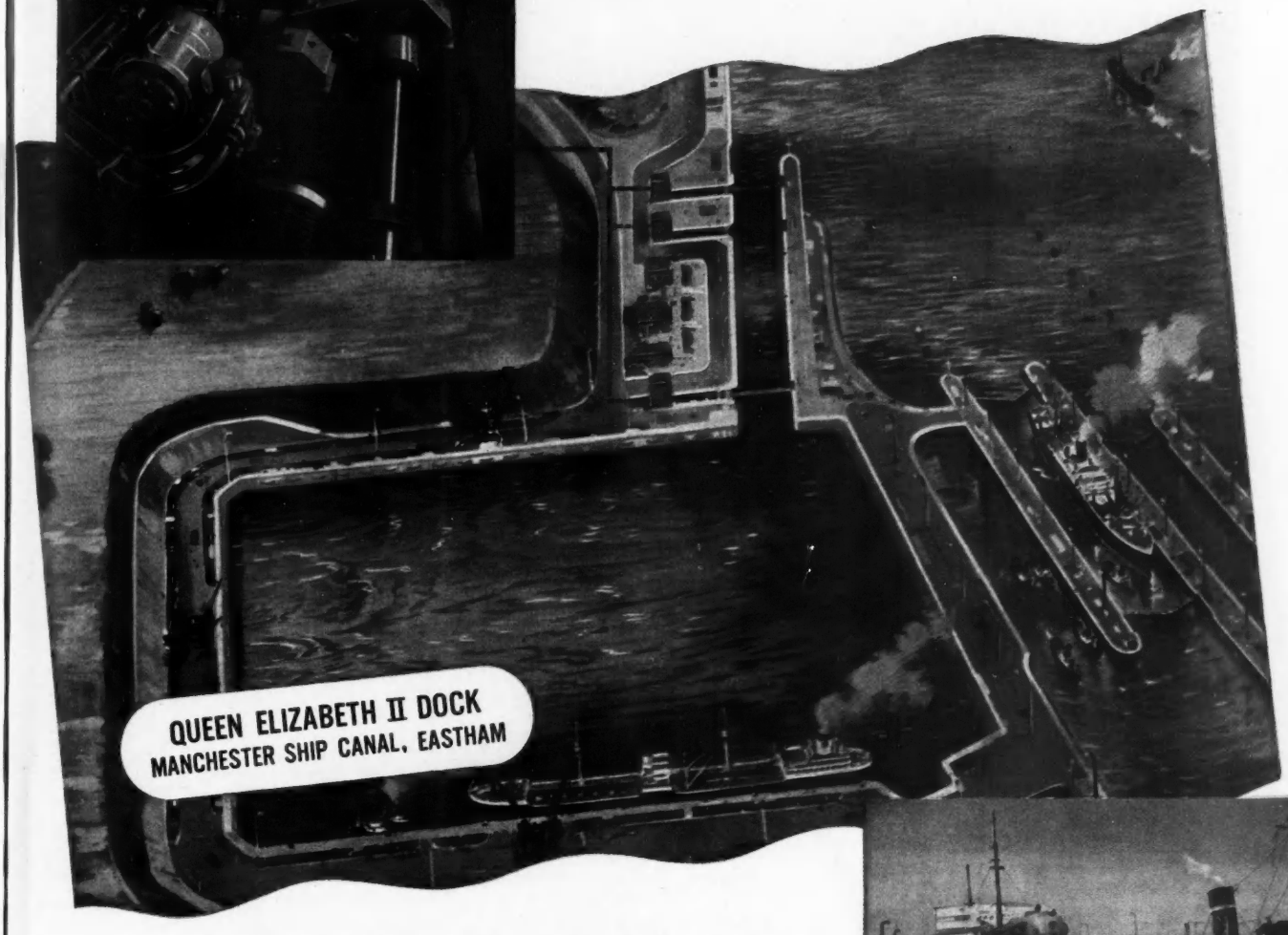

The Queen Elizabeth II Dock of the Manchester Ship Canal Company, built for the berthing of large oil tankers and opened recently, includes an entrance lock with three Sliding Caissons. To give the high starting torque needed to move these 1,700 ton Caissons and to provide the sensitive speed control required at each end of the travel, the winches are fitted with 'VSG' drives. The 'VSG' equipment incorporates automatic pressure control to prevent overload.

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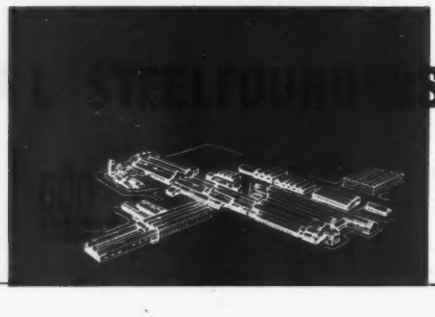

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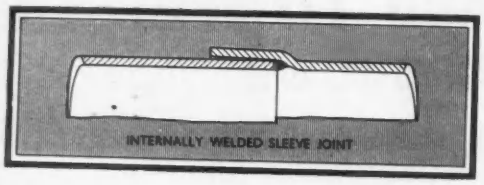

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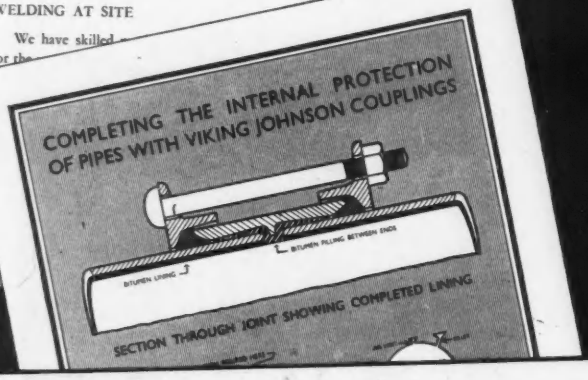
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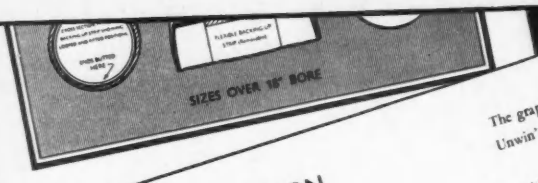
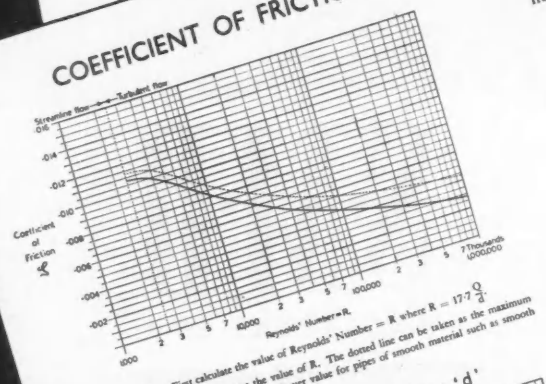
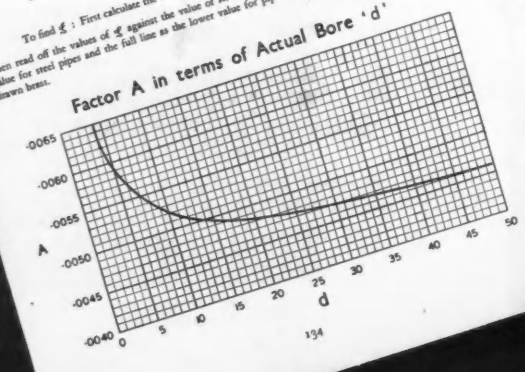


COEFFICIENT OF FRICTION



To find f: First calculate the value of Reynolds' Number = R where $R = 17{\cdot}7\frac{Q}{d}$.

Then read off the values of f against the value of R. The dotted line can be taken as the maximum value for steel pipes and the full line as the lower value for pipes of smooth material such as smooth drawn brass.



The graph opposite gives the values of A for the usual range of d.

Unwin's formula is

$$q = 76\sqrt{\left[\frac{d^5}{d+1{\cdot}714}\cdot\frac{P_1^2-P_2^2}{LU}\right]} \text{ Cu. ft./sec.} \quad \ldots\ldots(1)$$

from which any of the variables can be determined if the others are known.

To find the initial or final absolute pressures, the formula can be written

$$P_1 = \sqrt{\left[P_2^2+1{\cdot}75\,q^2\,LU\left(\frac{d+1{\cdot}714}{d^5}\right)\right]} \quad \ldots\ldots(2)$$

$$P_2 = \sqrt{\left[P_1^2-1{\cdot}75\,q^2\,LU\left(\frac{d+1{\cdot}714}{d^5}\right)\right]} \quad \ldots\ldots(3)$$

while if the diameter is to be found, a close approximation is

$$d = \sqrt[5]{M}\left(\frac{1{\cdot}37+\sqrt{M}}{1{\cdot}413+\sqrt{M}}\right) \quad \ldots\ldots(4)$$

where $M = \frac{1{\cdot}75\,q^2\,LU}{P_1^2-P_2^2}$

for all values of d not less than 3.

Lacey's modification of Unwin's formula is

$$Q = 182\sqrt{\left[\frac{d^5(P_1^2-P_2^2)}{\mathscr{f}LU}\right]} \text{ Cu. ft./hr.} \quad \ldots\ldots(5)$$

or

$$q = 48{\cdot}05\sqrt{\left[\frac{d^5(P_1^2-P_2^2)}{\mathscr{f}LU}\right]} \text{ Cu. ft./sec.} \quad \ldots\ldots(6)$$

where $\mathscr{f}$ is the coefficient of friction, to be read from the appropriate curve opposite for the value of Reynolds' number, R, given by $R = 17{\cdot}7\frac{Q}{d}$.

The lower curve may be taken as the lower limit for practical purposes, the dotted line is that determined by Lacey for cast iron pipes. In the absence of data entitling a smaller value of $\mathscr{f}$ to be used the dotted curve may also be applied to steel pipes.

The above formula can be applied directly to single mains if P_1, P_2, or L is to be found but if d, v and Q are unknown an approximate value must be assumed and checked above, and corrected as necessary. Such an initial value can be found from Unwin's formula if Lacey's is preferred for final use.

Meaning of Symbols

d = actual bore of pipe, in inches.
L = length of pipe, in feet.
P_1, P_2 = initial and final absolute pressures respectively, in lb. per sq. in.
Q = flow at atmospheric pressure, cubic feet per hour.
q = flow at atmospheric pressure, cubic feet per second.
U = specific gravity of gas relative to air as unity.

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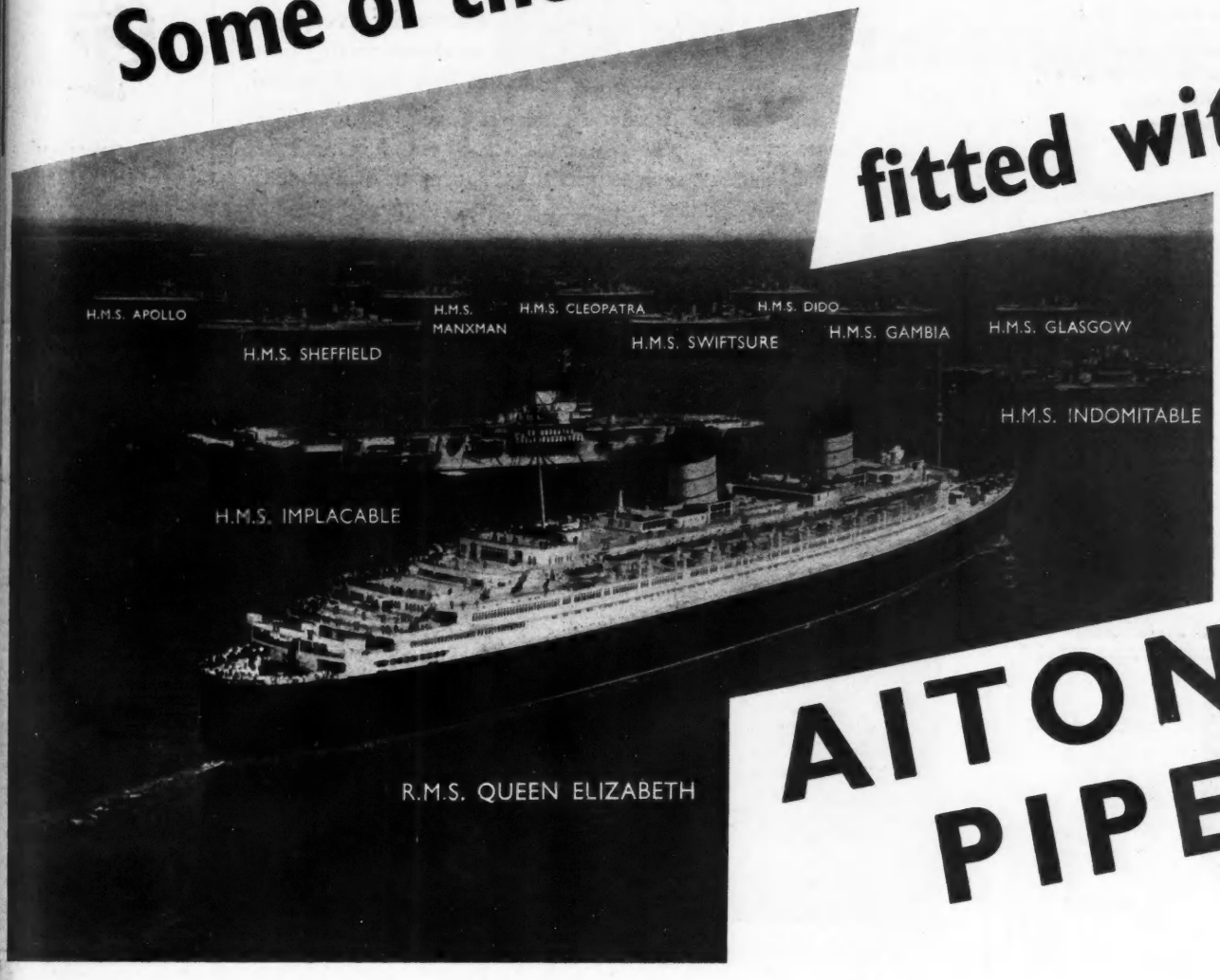

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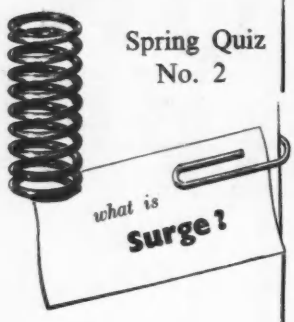

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Seldom has so much been moved so quickly (and cheaply) by so few! The photograph shows a lorry tipping coke into a C. & T. "Walrus" Loader, which in turn delivers to a 40 ft. C. & T. Stacker, at the rate of 80 tons per hour. Greater capacities can be achieved by speeding up the machines or by the use of wider carrying belts, and a wide range of loose substances can be handled.

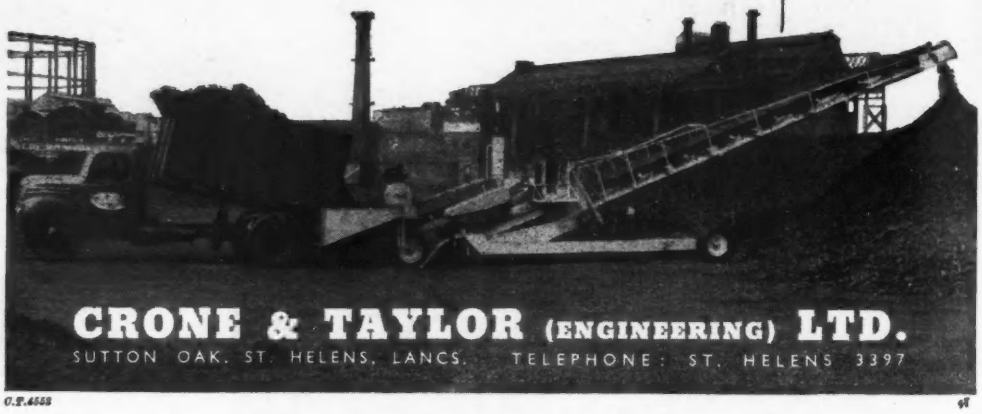
The "Walrus" Loader is the latest C. & T. aid to quicker, cheaper handling of loose bulk. It cuts out all intermediary stages, such as mechanical shovels or manhandling, and enables this type of operation to be performed by only one man—the lorry driver. The Stacker can be attached to the Loader by means of the tow-bar shown, so it is possible for both machines to be retracted simultaneously as the stockpile grows.

C. & T. Loaders & Stackers are extremely mobile and can be towed as far as 200 miles in 12 hours. They are available with diesel or electric drive.

C&T LTD.

"WALRUS" LOADER

We will be glad to send you complete details of these and other C. & T. materials handling aids on request.



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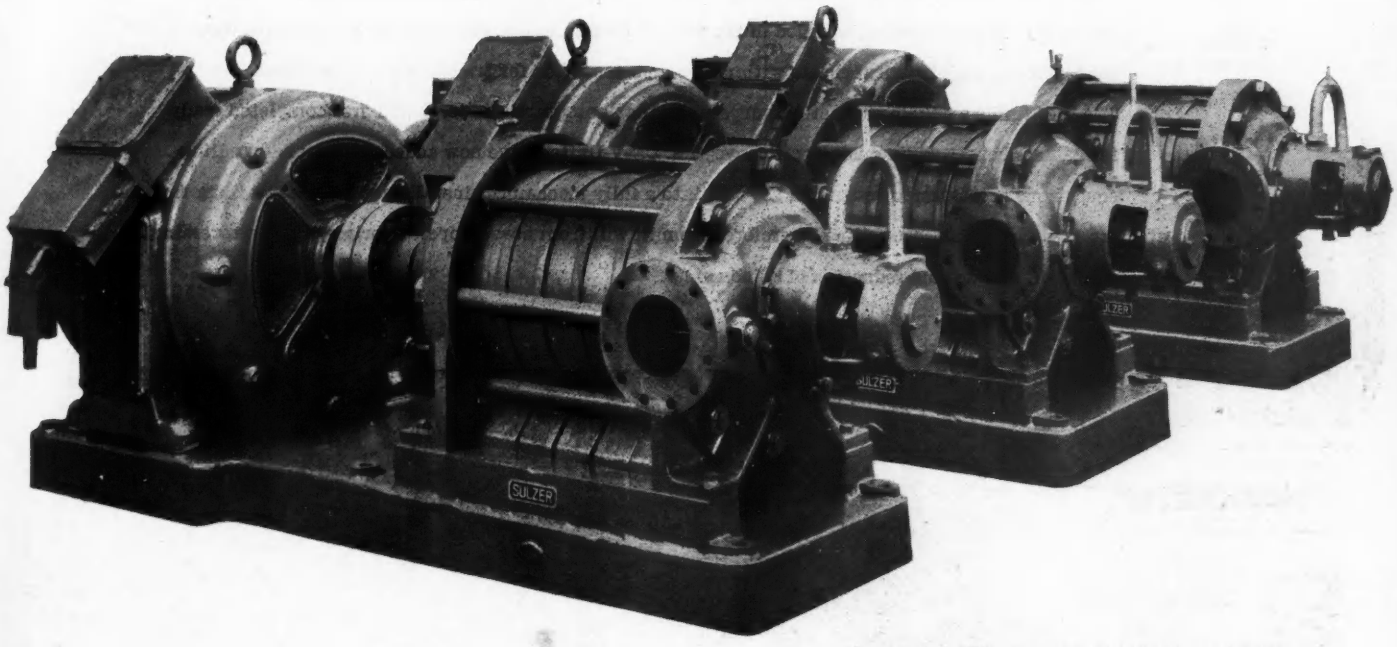

Three SULZER six-stage Highlift Centrifugal Pumps, supplied to a South Wales Water Board, each pumping 834 gals./min. against 600 feet head, at 1470 revs./min. Power absorbed 185 B.H.P. Efficiency 82%.

Sulzer Centrifugal Pumps of normal type and construction have been built since the sixties of last century. Standardisation of pump types has resulted in fundamental simplification of design while retaining good efficiency (in some cases as high as 90%) with the traditional quality of Sulzer products.

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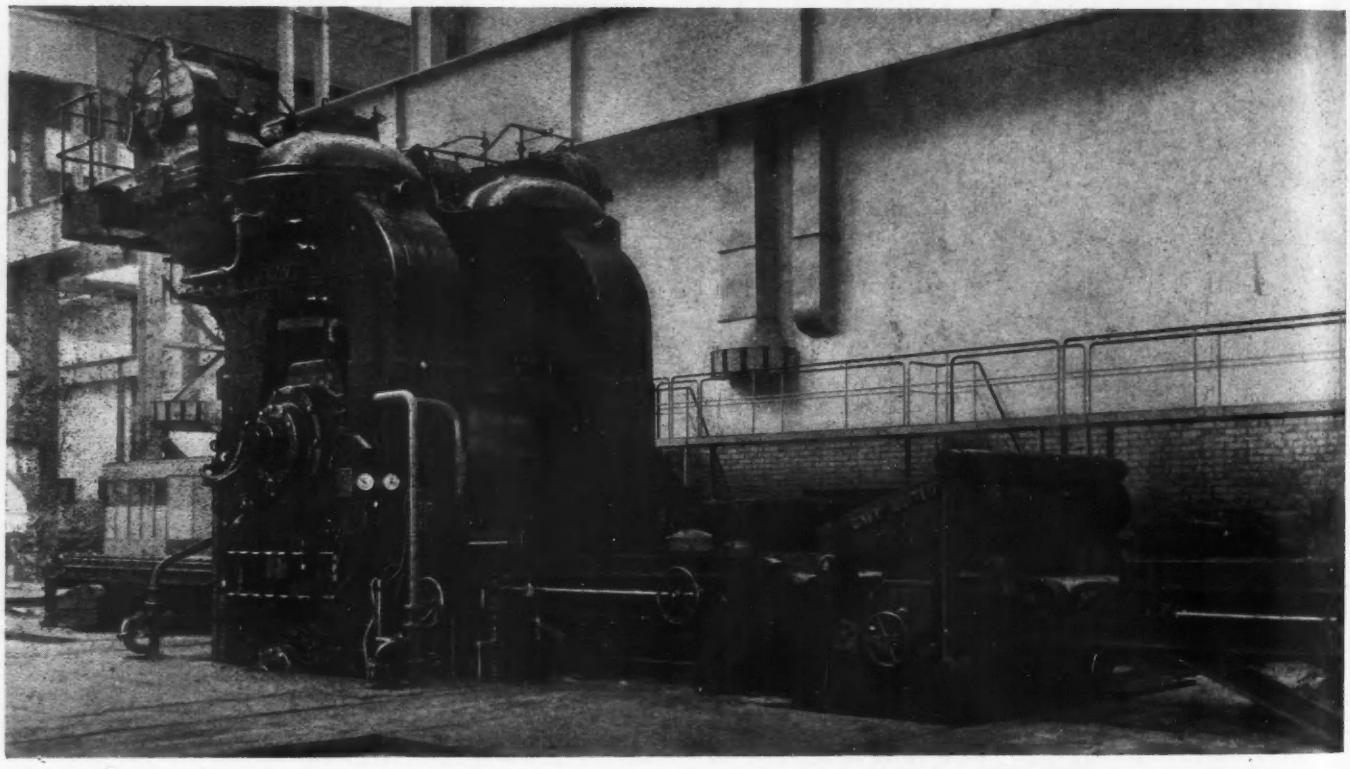
NEW COLD MILL FOR SILICON STEELS

AT SURAHAMMARS BRUKS A.B., SWEDEN

This 16½ in. and 53 in. by 56 in. Cold Sheet and Strip Mill has been designed specifically for the cold reduction of silicon steels. Installed in the works of Surahammars Bruks A.B., its principal duty is the production of electrical sheets with preferred orientation for transformer laminations.

The mill fulfils a double production purpose. As the photograph shows, it was first completed ready for hand-fed sheet rolling using belt conveyors. Davy-United have now added coiling and handling equipment necessary to transform the mill into a fully mechanical installation. While retaining the facility for single sheet rolling, therefore, the mill will from now on operate primarily as a reversing strip mill for the cold reduction of silicon steel.



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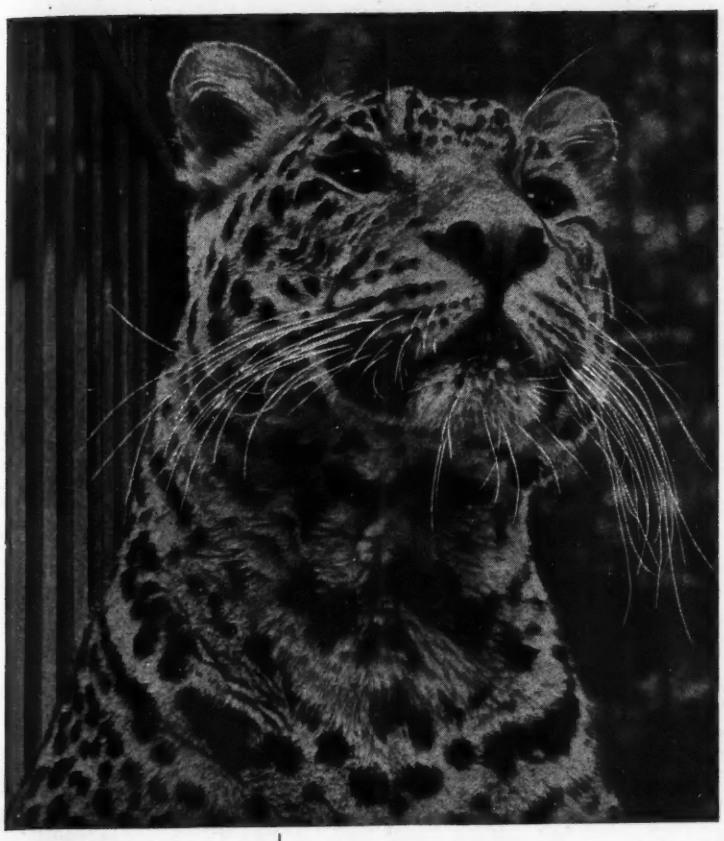
DAVY AND UNITED ENGINEERING COMPANY LIMITED, SHEFFIELD, ENGLAND



Wrought Iron keeps Danger at a Distance

These typical double cold bends show the remarkable ductility of Wrought Iron. Essentially fibrous in its structure, Wrought Iron possesses an exceptional toughness which gives it a high resistance to vibration and sudden shock—properties which it retains under severe cooling and heating stresses.

This face says 'danger'; but danger is not always so easily identified.

Today, and every day, human life everywhere depends on such hidden factors as the strength of a coupling or a cable chain. *For equipment that carries such heavy responsibilities, it is safer to specify Wrought Iron.*

The toughness of Wrought Iron is unequalled. Besides withstanding shock and overstrain, it staunchly resists rust and corrosion. Containing slag inclusions which reinforce its own susceptibility to welding, it is for many purposes both safer and more economical than mild steel as a long-term proposition—especially under exposed or wet conditions.

Wrought Iron in strips and bars and in a variety of sections is produced at the Midland Iron Works for innumerable uses. We will gladly send you a free copy of our Section Book, and our technical representative is at your service for consultation on any Wrought Iron application.

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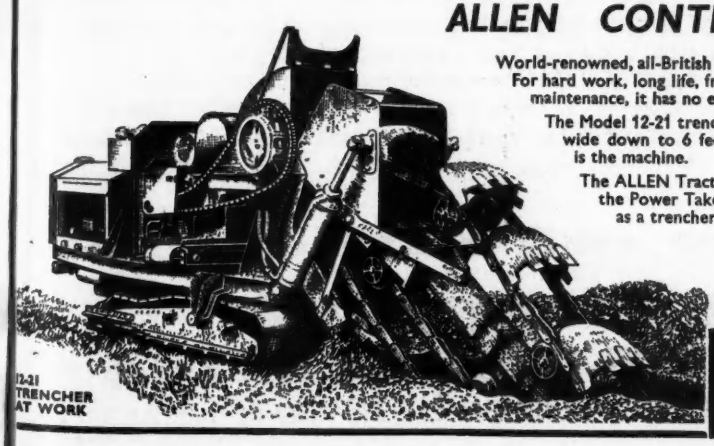

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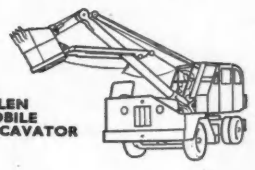
The Model 12-21 trencher will cut clean, fast trenches 13 to 21 inches wide down to 6 feet deep. For larger trenches the ALLEN 16-60 is the machine.

The ALLEN Tractor Operated Shovel, as its name implies, works off the Power Take-off of any tractor and can be used either as a trencher or a loader.

The Mobile Shovel has many applications.

Full details and catalogues on request.



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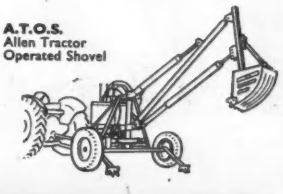

A.T.O.S. Allen Tractor Operated Shovel

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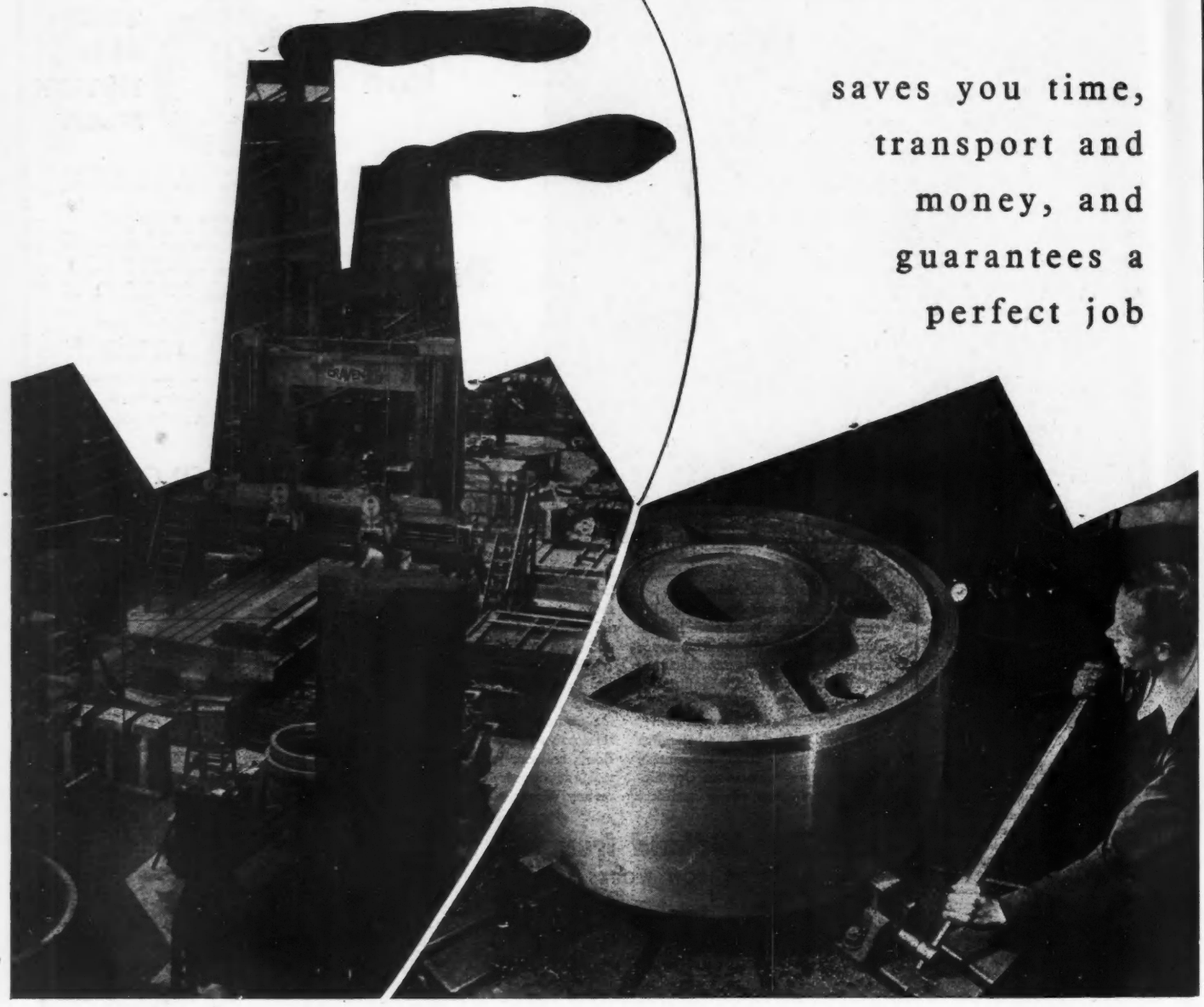
saves you time, transport and money, and guarantees a perfect job



It is a great advantage to the manufacturer if the foundry that produces his castings can also machine them. Steel castings delivered as machined units ready for assembly, enable the buyer to know from the start what the finished cost of the part will be; also he is doubly sure of receiving a perfect component. Lloyds new machine shop is equipped with a wide range of plant for the finished machining of every type of steel casting up to 25 tons in weight. Typical of Lloyds machining resources is the Craven Planer illustrated. It has a capacity of 10′ in width by 10′ in height, a stroke of 20′ and weighs 100 tons. Another spectacular machine is the Graffenstaden Horizontal Borer. It can bore to a diameter of 2′ 7½″ and possesses a maximum spindle stroke of 7′ 10½″. *Write for your copy of "Lloyds Craftsmen in Steel."*

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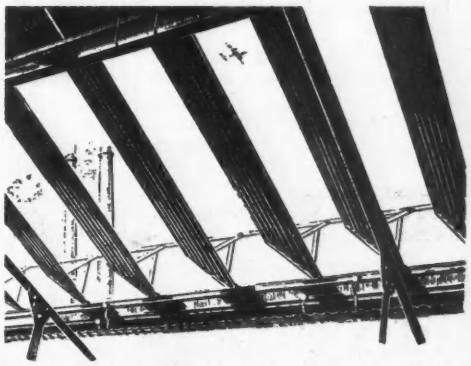

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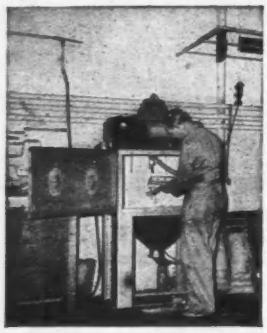

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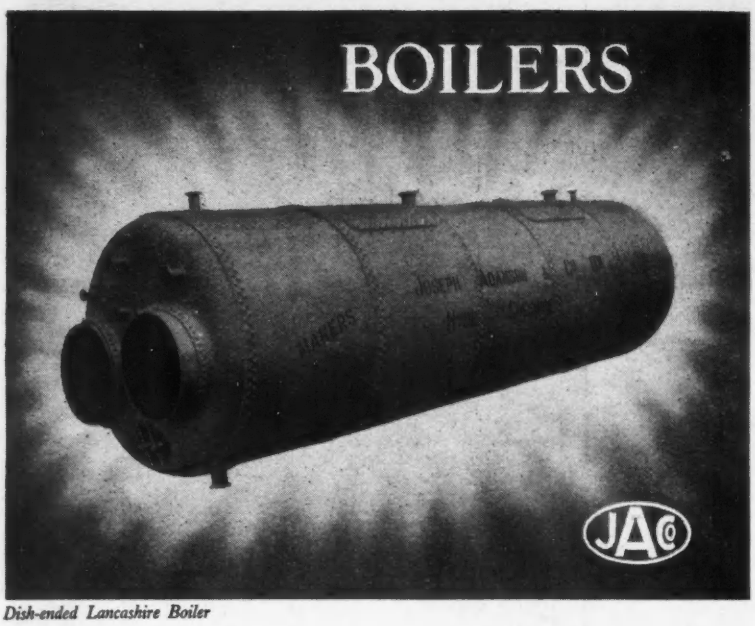

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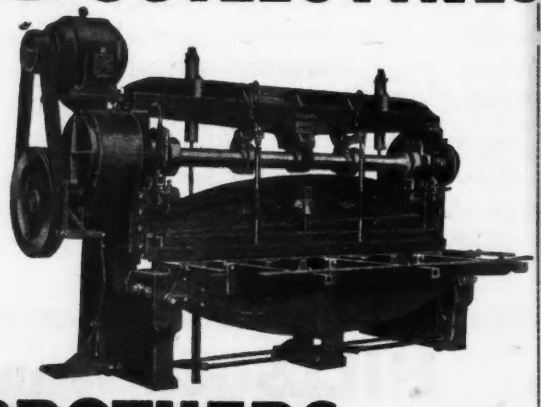

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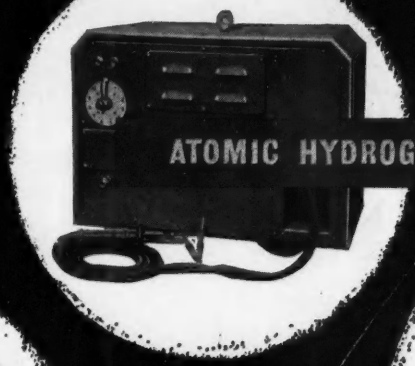

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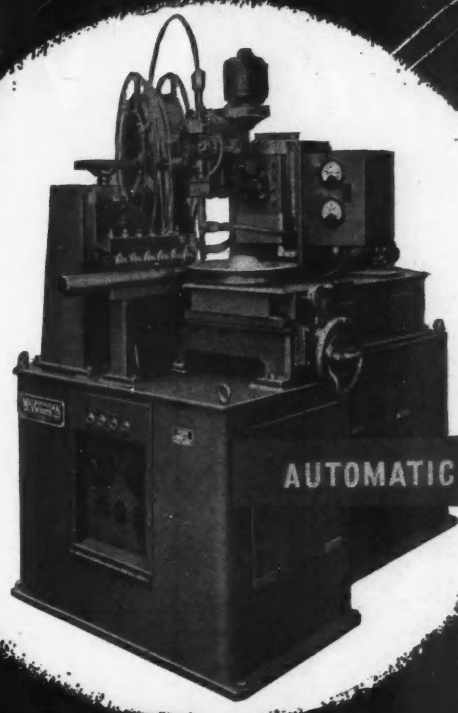

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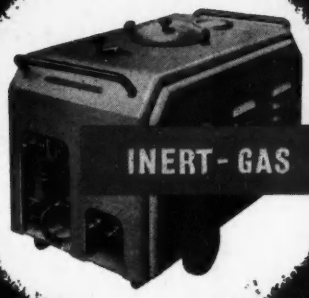

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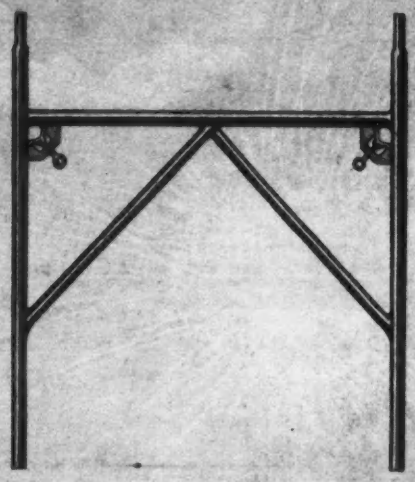

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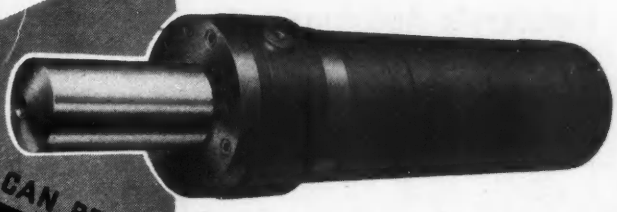

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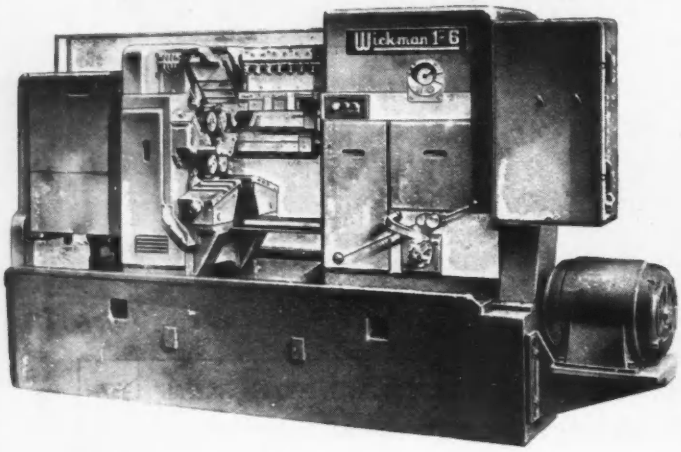

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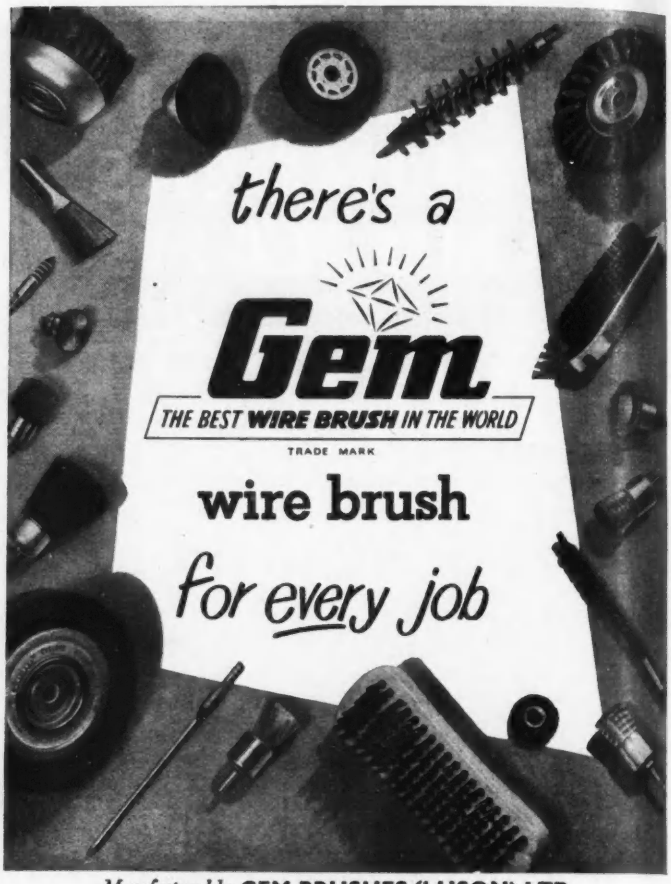

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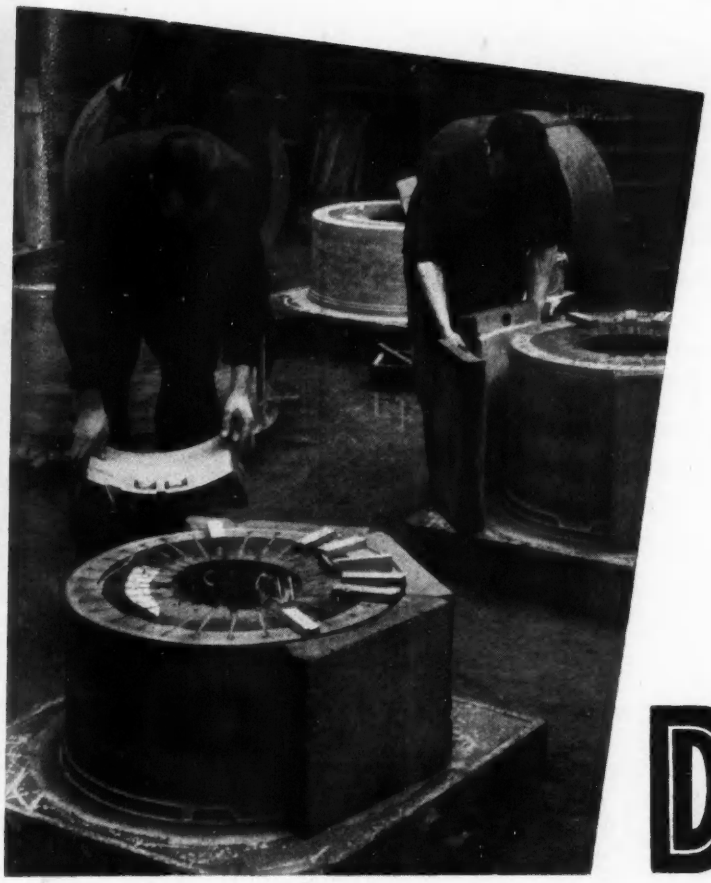

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Craftsmen in Steel

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In the Combine Printing and Developing Machine (Model 42/63) illustrated here, for example, one *unskilled* operator need only feed the original and the copying material into the machine in order to produce the finished print, dried, flat, and ready for trimming and collating. Exposing, developing and print delivery are completely synchronized.

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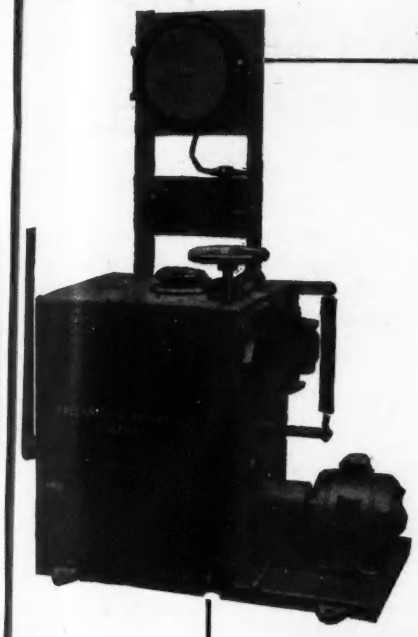
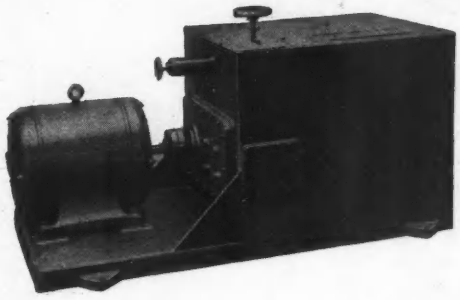


HYDRAULIC PUMPS

of MODERN DESIGN

Here are two pumps from a wide range. *Right:* Greenbat variable stroke high-speed high-pressure pump, for handling oil pressures up to 2 tons per sq. in. *Left:* Hele-Shaw Beacham pumping unit.

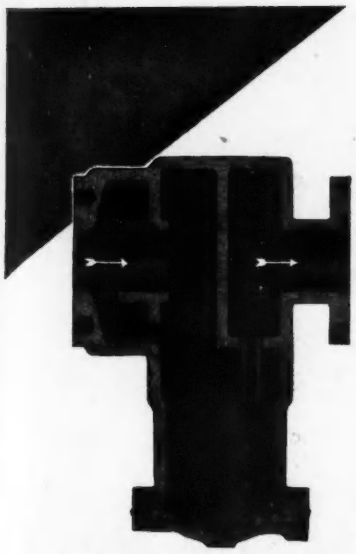


GREENBAT

OIL PRESSURE PUMPS

GREENWOOD & BATLEY LTD. ALBION WORKS · LEEDS

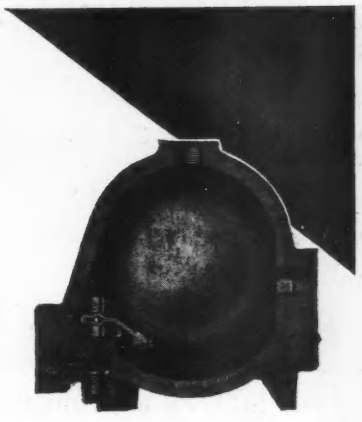
GPIA



"The Lancaster" REGD TRADE MARK

STEAM SPECIALITIES

for every purpose



IMPACT SEPARATOR

FOR SEPARATING OIL or WATER from COMPRESSED AIR or STEAM.

Large numbers are in use in Colliery Air Mains, Compressor Intercoolers, Spray Painting Plants, and many other installations where dry air is essential.

CAN BE SUPPLIED COMBINED WITH TRAP or SEPARATE AIR TRAP.

AIR TRAP for draining water from AIR MAINS

"The Lancaster" Air Trap consists of a sealed float which rises and opens a discharge valve when the water collects in the trap. It represents a DEAD seal against leakage of air. Two alternative inlets are provided, vertical or horizontal. Will lift the discharge water. Supplied in ½ in., ¾ in. and 1½ in. sizes.

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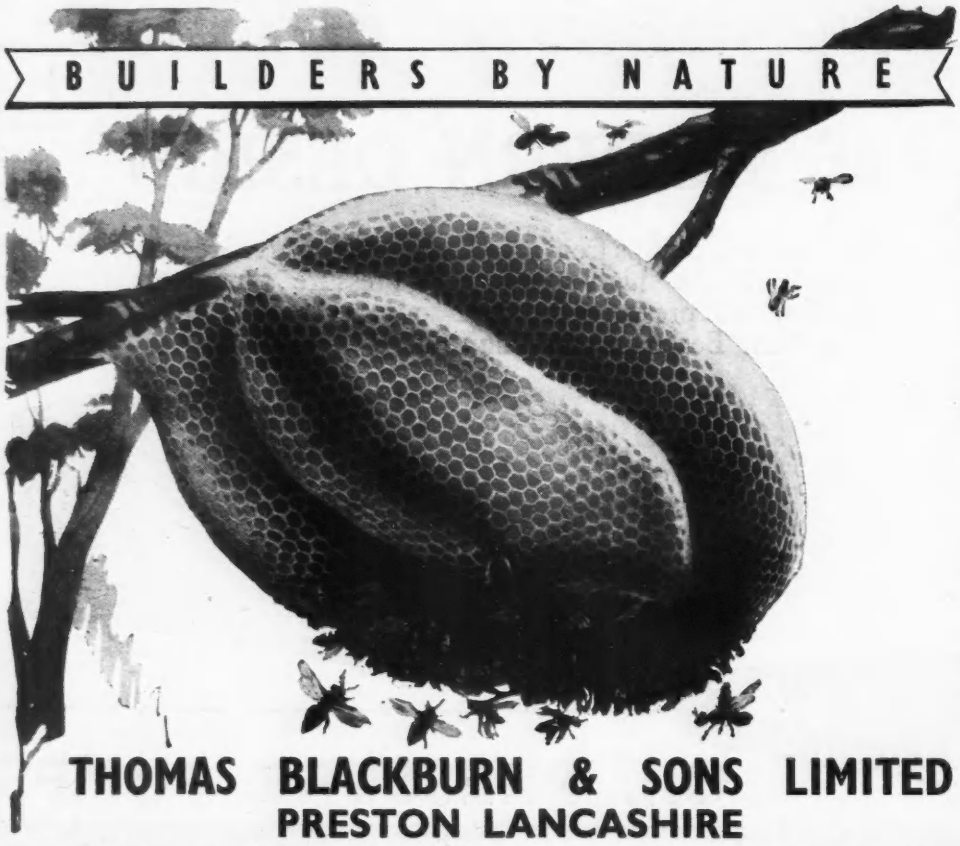
BUILDERS BY NATURE



THOMAS BLACKBURN & SONS LIMITED
PRESTON LANCASHIRE

London Office: 8, Bloomsbury Square, W.C.1 *Telephone:* HOLborn 8638
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Fabricators in Steel. Constructional Steelwork. Iron Castings. Railings and Gates. Metal Windows. Farm Implements.

NO. 4 THE BEE

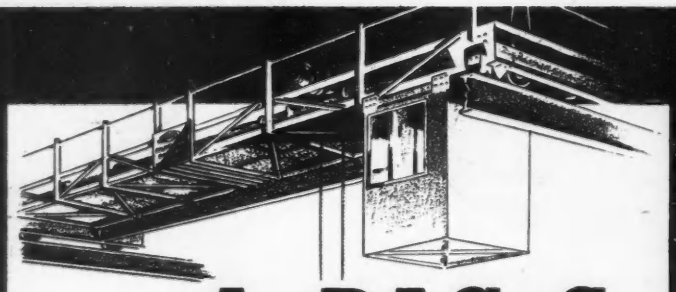
The building of comb by bees is, like everything they do, a masterpiece of co-operation and efficiency. The worker bees cling to each other in a pear-shaped mass so that they become very warm. Then, from tiny pockets under the abdomen, frail looking, clear scales of wax appear. Other bees take the wax to construct the comb.

All the cells, except the round ones in which queen bees are reared, are six-sided, for the bees have found the form which avoids all waste of space, effort and time. Another advantage is that the cells support each other and can therefore be constructed of the lightest materials. The honey cells are completely waxen and are rendered air-proof with a wax capping. The brood cells, however, in which young bees are raised, have a cap of a porous wax and pollen mixture.

The bees perfect a delicate but craftsmanlike piece of work by sloping the cells upwards slightly from the base, so that they are easier to fill, and safer as receptacles for honey, than if they were built horizontally.

Man has been only too glad to learn the lesson which the bee teaches in lightweight, economical and highly proficient construction.

18.



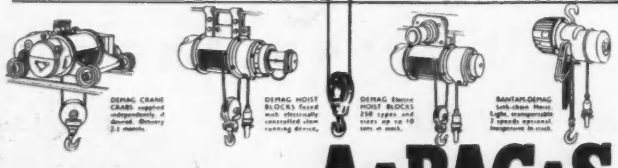
AABACAS

ELECTRIC OVERHEAD TRAVELLING CRANES

rise to the occasion

We, of Aabacas, offer you more than good, proved, longlasting, electric overhead travelling cranes of all kinds, a choice of over 250 types and sizes of DEMAG hoists up to 10 tons capacity, and other special handling devices and components. We also place at your disposal the combined resources of our experienced technical engineers who have been solving every kind of handling problem you can imagine, to plan an produce the best equipment at the price for your job. And we are just as interested—just as careful—in executing small jobs as large projects. Perhaps we could save you a lot of capital expenditure—and increase your productivity—by modernising your older cranes?

We hope you will ask for our Technical Engineer to call and advise you . . . we are sure you will be glad you did so.

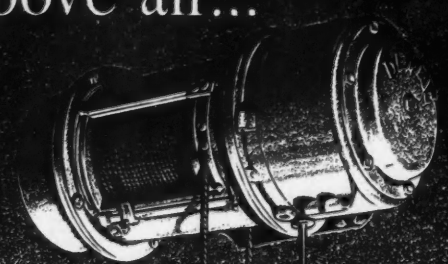


Please address your enquiry to Sales Director

AABACAS

Telephone: BIRKENHEAD 4747

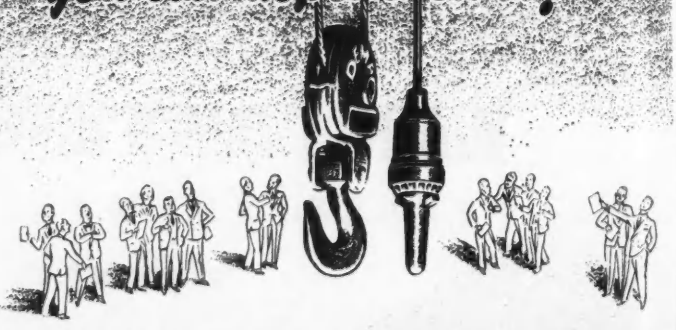
Above all...



DEMAG

THE WORLD-FAMOUS ELECTRIC HOIST BLOCK

you can depend on it!



ENGINEERING CO., LTD., BIRKENHEAD, ENGLAND

SOLE BRITISH DEMAG AGENTS

Dear Sir,
delivery to above Works for two Overhead
Travelling Cranes with a span of 40'
to travel along a common gantry 76' long.
DO THE JOB!

Whatever the requirements...

Heavy Steelworks Duty or

Light Factory Duty

40 feet span or

120 feet span

Intermittent Duty or

Continuous Duty

Lifting capacity 3 tons or

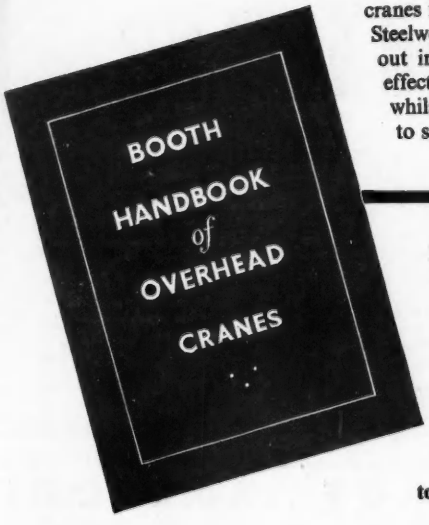
Lifting capacity 200 tons

1000 maximum hours per annum or

5000 maximum hours per annum

a BOOTH standard electric overhead crane will

THE BOOTH METHOD of classifying overhead electric travelling cranes to suit varying service factors means that from a range of five classes of cranes, it is possible to offer a standard crane to serve almost any industrial requirement. We manufacture cranes for light duty up to continuous process cranes for Steelworks, and installations within this range have been carried out in many factories and Steelworks in this country and abroad. Grading of cranes effects considerable economies by making it possible to standardise components within each group whilst still retaining the advantages from the purchaser's point of view of being able to choose a crane to suit the duty required.



The Booth Handbook of Overhead Cranes is a comprehensive publication containing practical information which will be of interest to crane users. It fully explains the Booth method of classifying overhead cranes to suit varying service factors and gives detailed information and hints on fixing crane particulars which would be of assistance to any firm contemplating additional craneage.

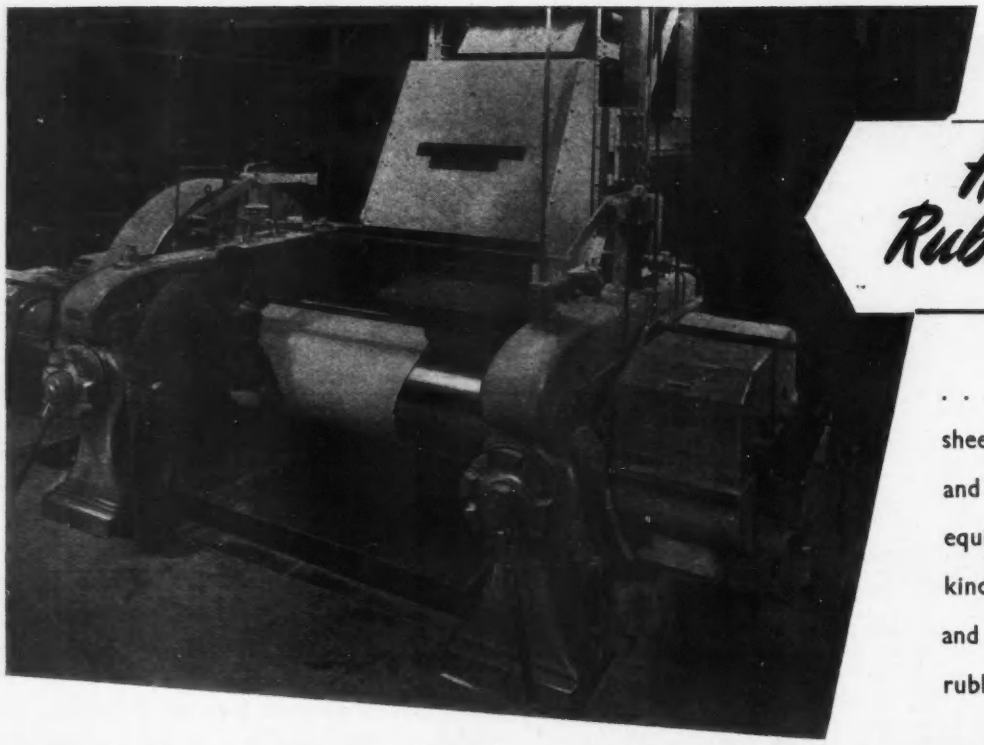
From a wide experience in designing and building all types of crane installations we should be pleased to submit proposals and designs to suit any requirements.

BOOTH CRANES

JOSEPH BOOTH & BROS · UNION CRANE WORKS · RODLEY · LEEDS Telephone: Pudsey 3168 Telegrams: "Cranes, Rodley."

Associated with CLYDE CRANE & ENGINEERING CO., MOSSEND, SCOTLAND. Proprietors: CLYDE CRANE & BOOTH LTD.

J/B1/17



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. . . A rubber mill equipped with sheeting rolls, extruding machines and moulding presses. A rubber mill equipped and staffed to produce all kinds of mixings, mouldings, bondings and extrusions in rubber, in fact rubber materials for any trade!

MIXINGS • MOULDINGS • EXTRUSIONS • BONDINGS in RUBBER

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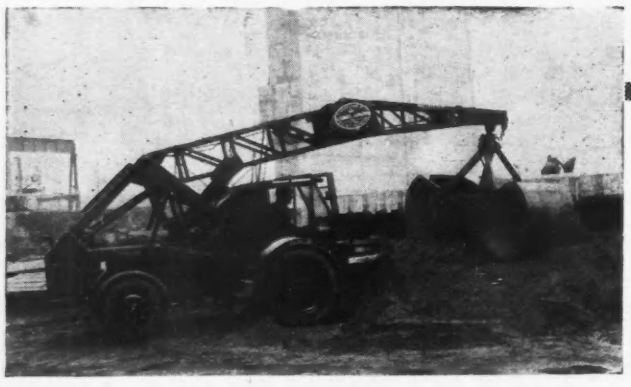
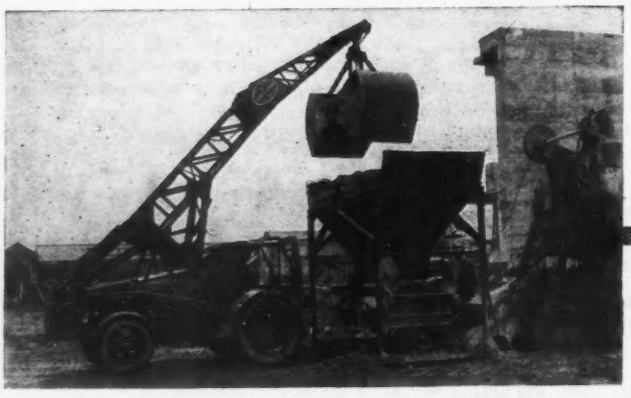


The complete versatility of the Jumbo Junior is shown in this photograph—note the low reach and unimpaired operator's vision. Photograph by courtesy of Simon-Carves Ltd.



This action photograph shows the Jumbo Junior feeding high level gravel hopper. Photograph by courtesy of Simon-Carves Ltd.

SIMON-CARVES LTD. USE

JUMBO JUNIOR

THE LOWEST PRICED MACHINE TO LOAD AND UNLOAD

Outstanding 2 Ton Hydraulic Crane with low operating costs and easy maintenance.

Here is a sturdily built powerful hydraulic crane for speedy and economical LOADING . . . LIFTING . . . SHIFTING . . . HAULING . . . AND ABOVE ALL COMPLETE UNLOADING. It operates faster—with maximum mobility—and speeds up every job with its effortless control. The power unit is a FORDSON 42 B.H.P. DIESEL and it has 6 forward and 2 reverse speeds.

• Front wheel drive for maximum tractive effort • Hydraulically operated — no winches or cables • Rear wheel steering — less driving fatigue — greater manoeuvrability • Will pass under 8′ 4″ doorway • 12′ 6″ turning radius • Operates 1½ cu. yard grab • Unloading height 11′ 5″ • Low fuel consumption 2½ hrs/gal.

Unload lifting costs — get right down to the job with the NEW JUMBO JUNIOR

TAYLORS OF SALFORD

— mobile cranes to you!

F. TAYLOR & SONS (MANCHESTER) LIMITED, 142 BOLTON ROAD, SALFORD 6, LANCS

OVER 80 YEARS
EXPERIENCE IN
ALL BRANCHES
OF HYDRAULIC
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TECHNIQUE

EUMUCO

High speed self-contained drop forging hammer

with
direct
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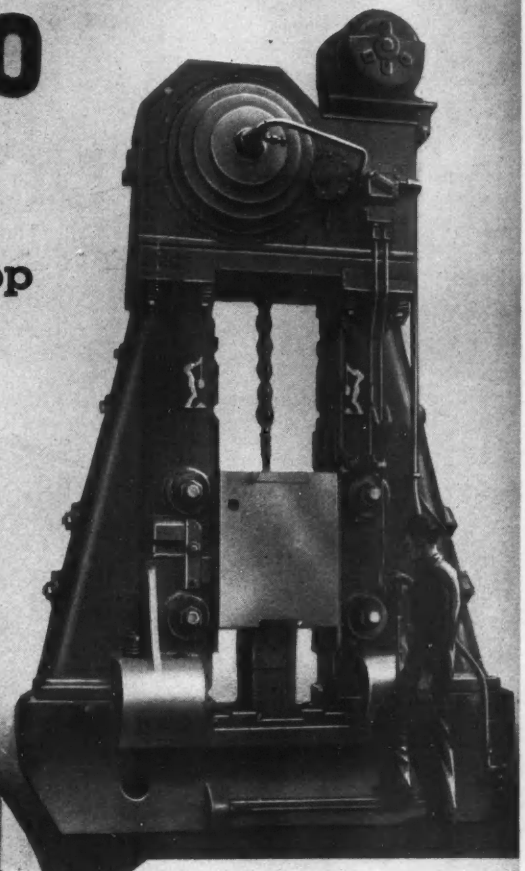
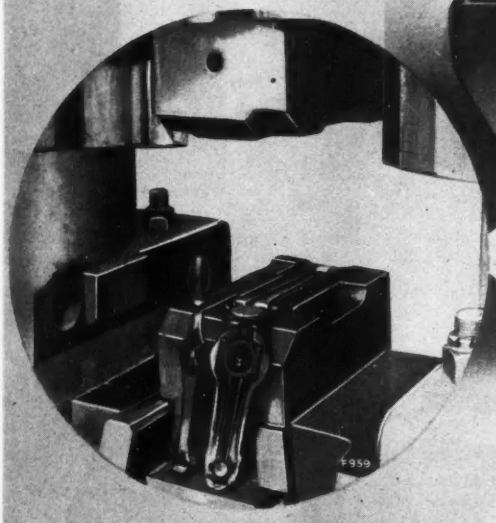




When forging with combined dies light and heavy strokes are easily controlled.

5/52

EUMUCO

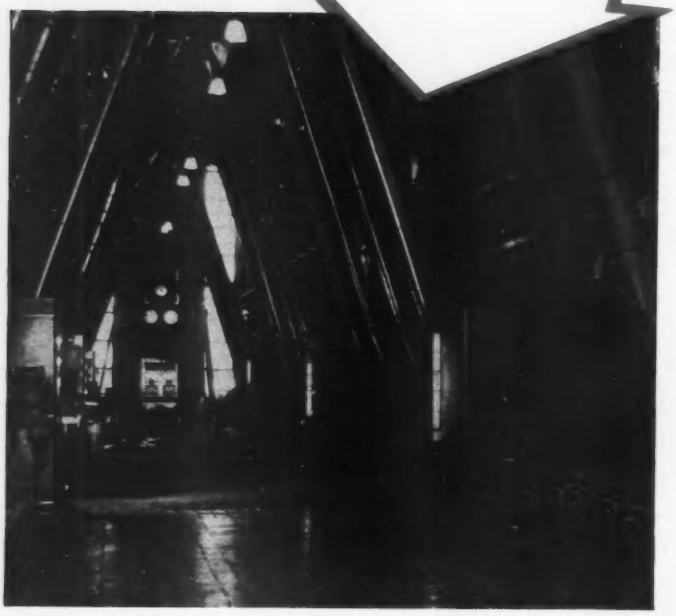
LEVERKUSEN
GERMANY
ESTABLISHED 1869

IN THIS FACTORY AT LEVERKUSEN, GERMANY, THE WORLD RENOWNED EUMUCO HAMMERS AND PRESSES ARE MAD

All enquiries for these machines should be sent to :—

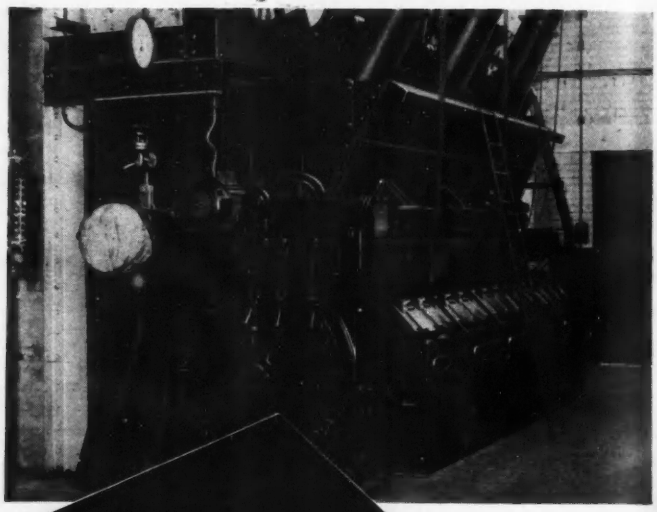
MESSRS. WINFIELD-SMITH ENGINEERING SUPPLIES LIMITED

In power stations



Firing aisle showing twin 'L' stokers at an Electricity Generating Station.

Small 'L' stoker installation at a Chemical Works.



and in factories

ICL ENTERPRISING ENGINEERING Saves coal

INTERNATIONAL COMBUSTION LIMITED

LONDON OFFICE: NINETEEN WOBURN PLACE, W.C.1. WORKS: DERBY, ENGLAND; PORT ELIZABETH, SOUTH AFRICA; SYDNEY, AUSTRALIA

SG21

CHALLENGERS *in name*
CHALLENGERS *in performance*

Three years ago, the first British Challenger went into action. Today, Challengers are firmly established as leaders in the field of earth-moving. Tough Challenger tractors are now at work in over fifty countries throughout the world, helping to grow more food, to make new roads and railways, to build up new industries, and to make permanent friends for Britain. There is a Challenger for every job—Challenger 1, 50 b.h.p., Challenger 3, 95 b.h.p., and Challenger 4, 150 b.h.p., all can be supplied with matched ancillary equipment. Because of their proved record for reliability and service, more and more crawler tractor operators at home and abroad are changing to Challengers. And with good reason—because Challengers have demonstrated that, under really arduous conditions, they can do more work, do it faster, and keep on doing it.

AFTER-SALES SERVICE

Wherever a machine is sold, spares are readily available, backed by a world-wide service organisation.

FOWLER (LEEDS) Challenger British Diesel Crawlers

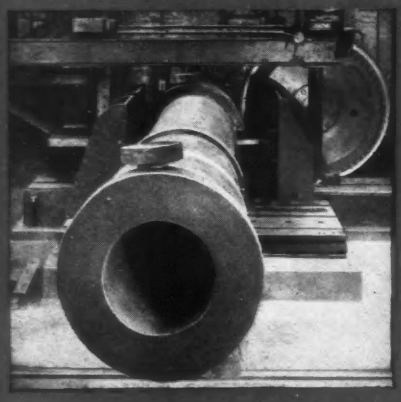
John Fowler & Co. (Leeds) Ltd., Leeds, 10

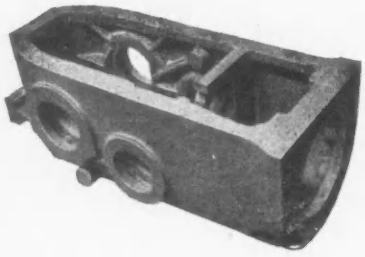
PRODUCTS OF THE MARSHALL ORGANISATION, GAINSBOROUGH, ENGLAND

Concessionaires for Great Britain: Thos. W. Ward, Ltd., Albion Works, Sheffield, 4

SPORTING & FOUNDRY LIFE

(huntin', shootin', castin')

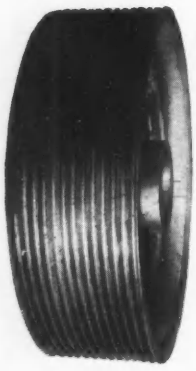




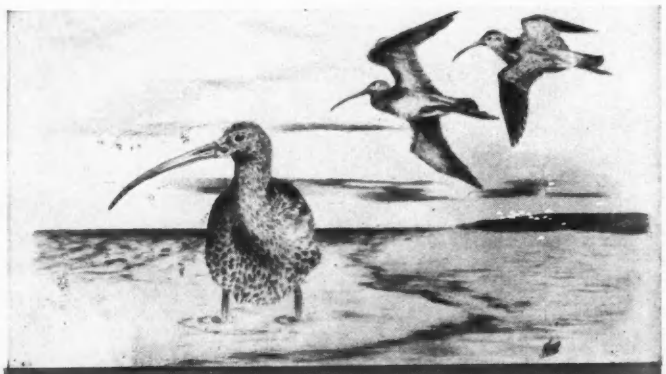
We are looking up the spout of a worthy piece of sporting artillery (above) which we once cast when our everyday fowling pieces were in dock because of powder fouling. The reason we tried using cannon was that if we were to have missed a phestoon of pheasants, or a pride of partridges when the cannon balls went up, we might have got a score of duck or a surfeit of lampreys when the balls came down. Actually, we never even sniped a snipe with it, and quails quailed at the sight of it. On one of our rotary planers we machined the ends as flush as our rich uncle.

The designer of the gearbox (above) said "Let 'em lubricate the gears with water; let 'em knock the gear lever in with a 28 lb. hammer; let 'em grind the gears like a barrel organ; this box is going to take it". We cast it in our foundry. It took it.

Here are some castings (left) which we produced in moments of self-expression. Much thought and feeling went into their creation. They sold readily, and a customer telephoned to tell us that we had plenty of clues; it might have been curlews; we couldn't quite hear what he said for the sound of gunfire outside the offices.



CASTINGS IN WEST COAST HEMATITE IRON



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DISTINGTON ENGINEERING COMPANY LIMITED

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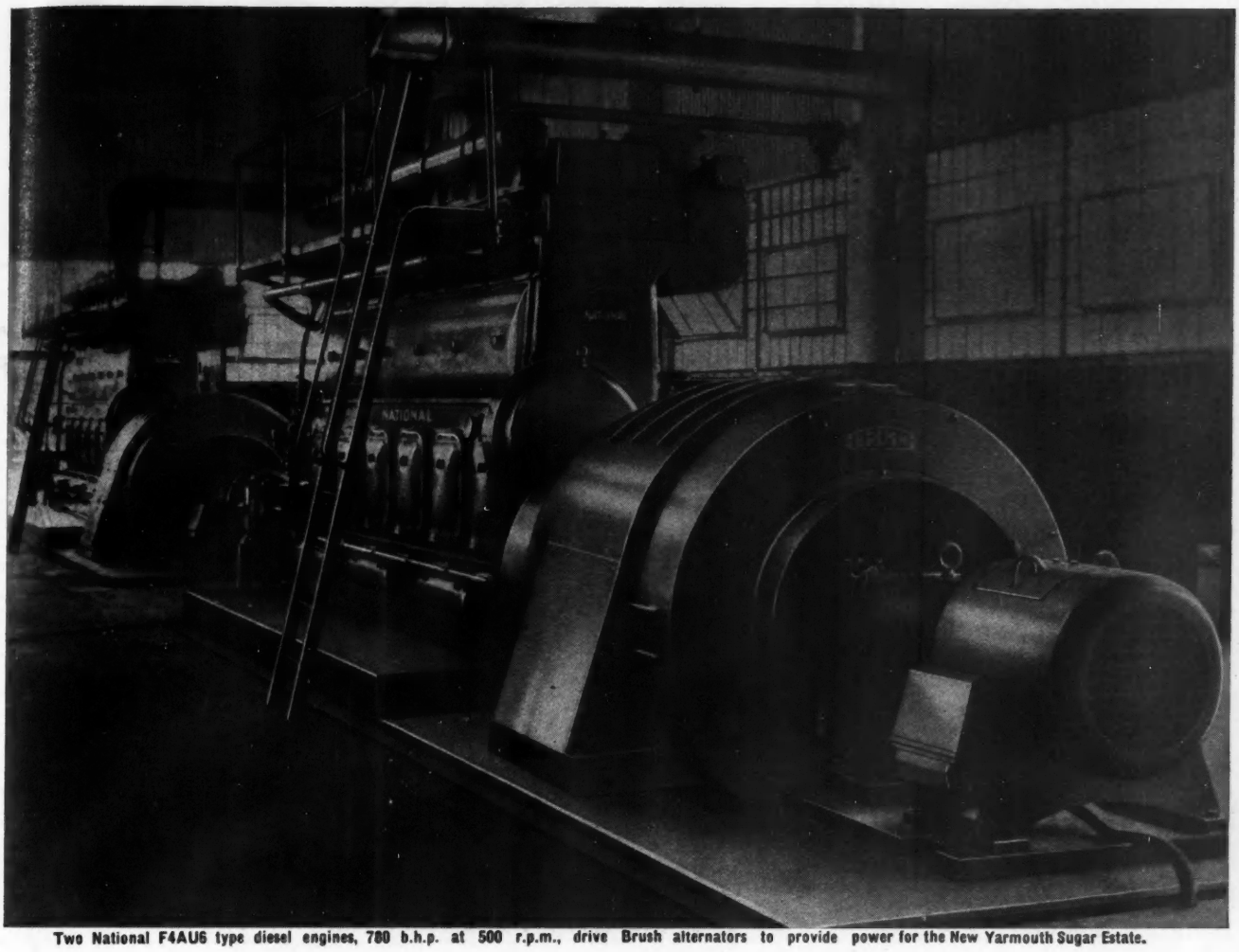

Two National F4AU6 type diesel engines, 780 b.h.p. at 500 r.p.m., drive Brush alternators to provide power for the New Yarmouth Sugar Estate.

SWEET RUNNING IN JAMAICA

New Yarmouth Sugar Estate, Jamaica, B.W.I., have been using National engines for many years. The first 400 b.h.p. diesel installed in 1937 has given over 80,000 hours service and its performance resulted in three additional engines being installed between 1943 and 1948.

In 1951 more land was put under cultivation, demanding still further power. In 1953 two of the latest 500 kW National diesel alternator sets (shown above) were installed.

The generating station operates on a 24-hour basis in both wet and dry seasons.

Without a doubt – NATIONAL *diesels*

THE NATIONAL GAS AND OIL ENGINE CO. LTD., WELLINGTON WORKS, ASHTON-UNDER-LYNE, LANCASHIRE.

N. 215.

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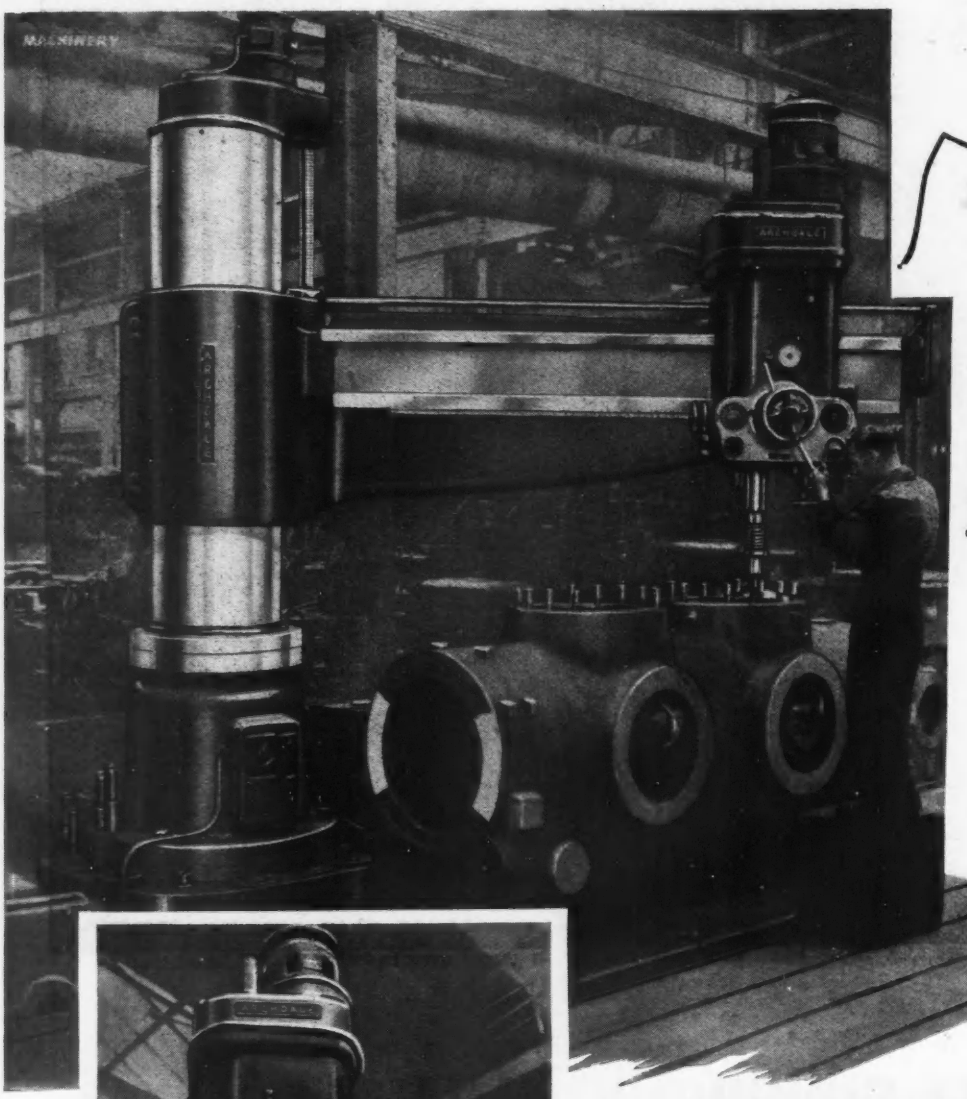

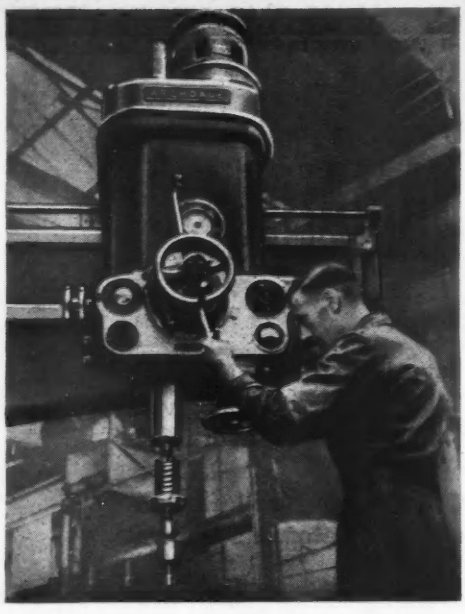

DRILLING TAPPING AND STUDDING

CRANKCASES FOR HEAVY MARINE REFRIGERATION EQUIPMENT AT J. & E. HALL LTD. DARTFORD

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HYDRAULIC

for maximum performance

This versatile and powerful machine, with **hydraulic control** and **pre-selection of speeds and feeds,** has shown outstanding results on heavy duty drilling, tapping and studding, at J. & E. Hall Ltd., Dartford.

Capacity from solid, in cast iron 4in., and in steel 3½in. dia. There are 22 speeds, 11 to 1450 r.p.m. and 18 feeds, 8 to 540 r.p.i. Sizes range from 5ft. to 12ft. spindle radius.

- *PRE-SELECTION OF SPEEDS AND FEEDS*
- *HYDRAULIC CONTROL*
- *AUTOMATIC LOCKING*

JAMES ARCHDALE & CO. LTD. BIRMINGHAM
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SADIVAR SPEED VARIATOR

53 ff

A 7 to 1 Speed Range
Negligible Slip
Accurate and steady Speed Setting
High Efficiency
Horizontal or Vertical Mountings
Attractive Prices – Very Short Deliveries

As one single compact unit, the Sadivar variator can be supplied built in with a Sadi speed reducer, thus combining speed variation with high reduction ratios and a wide variety of output shaft torques.

The Sadivar variator is usually supplied complete with flange mounted motor. Note comparable sizes of motor and variator.
Ask for literature EV554.

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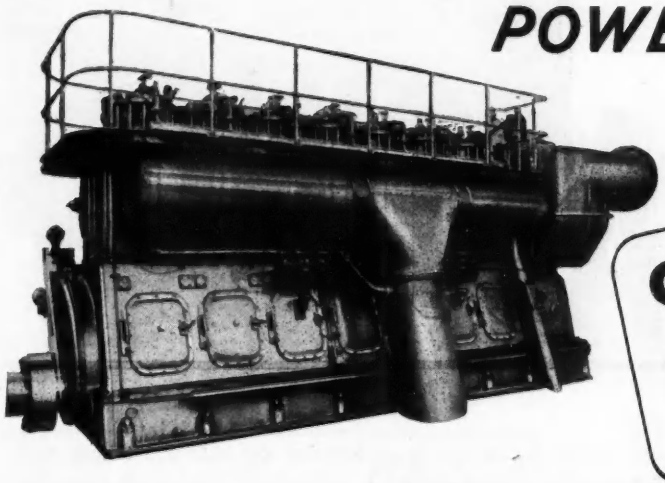
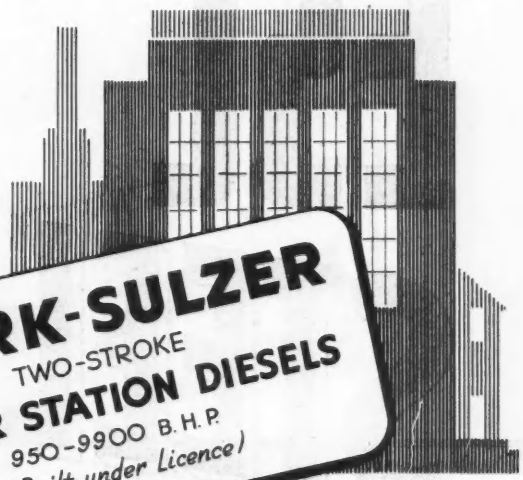
Agencies in all Commonwealth countries, North and South America, West European countries and colonies.

THIS *in* THIS *makes* POWER



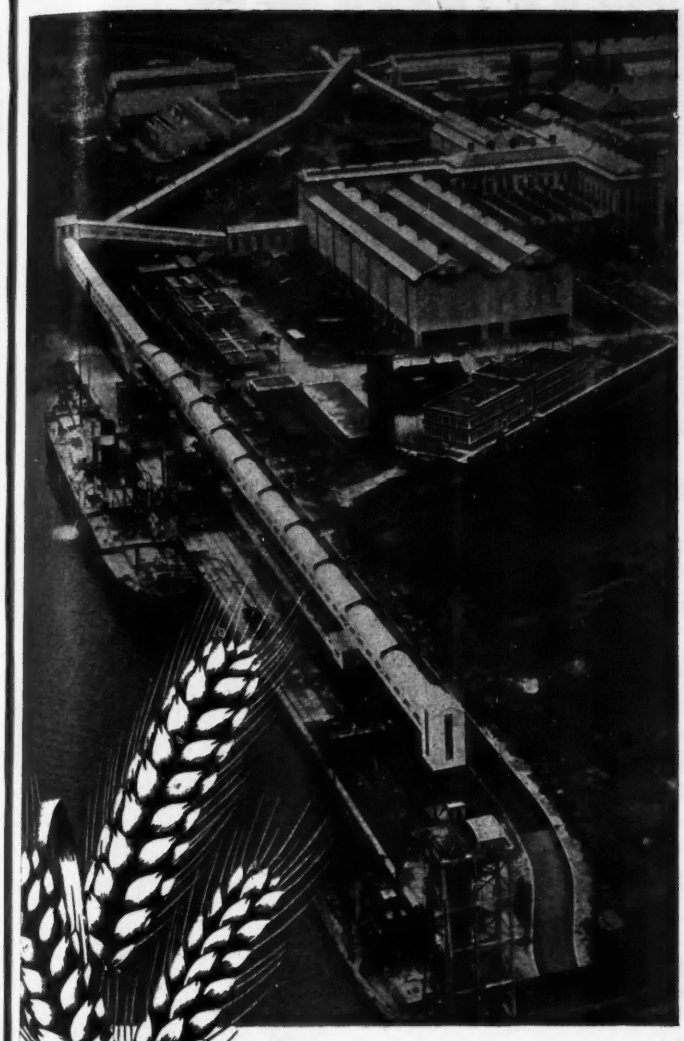


CLARK-SULZER
TWO-STROKE
POWER STATION DIESELS
950-9900 B.H.P.
(Built under Licence)

GEO. CLARK (1938) LTD.
SUNDERLAND

Employing craftsmen who have inherited the skill and technique of their predecessors and using the most modern production methods, the ESC Steel Foundry is able to supply the best heavy, medium and light weight steel castings for many branches of industry.

ENGLISH STEEL CORPORATION LTD · SHEFFIELD



increased productivity lower costs

Part of a conveyor system supplied to Fisons Limited, Immingham. The plant comprises 36" intake and distribution conveyors, 30" bulk loading-out conveyors to vessels, bagging plant to road or railway, also coal and ash handling plant. The total length of the conveyors in the complete installation is approximately two miles, the longest one being over 1,000 ft. centres.

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Handling Plant

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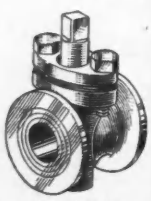

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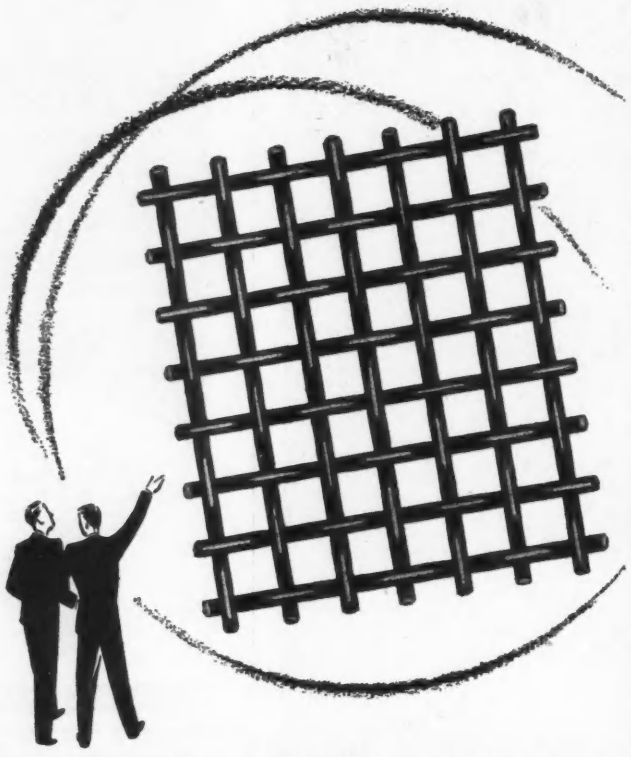

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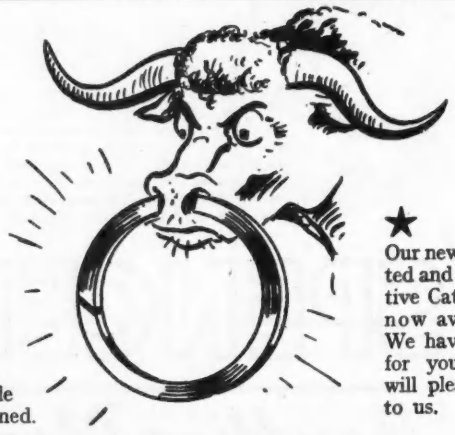

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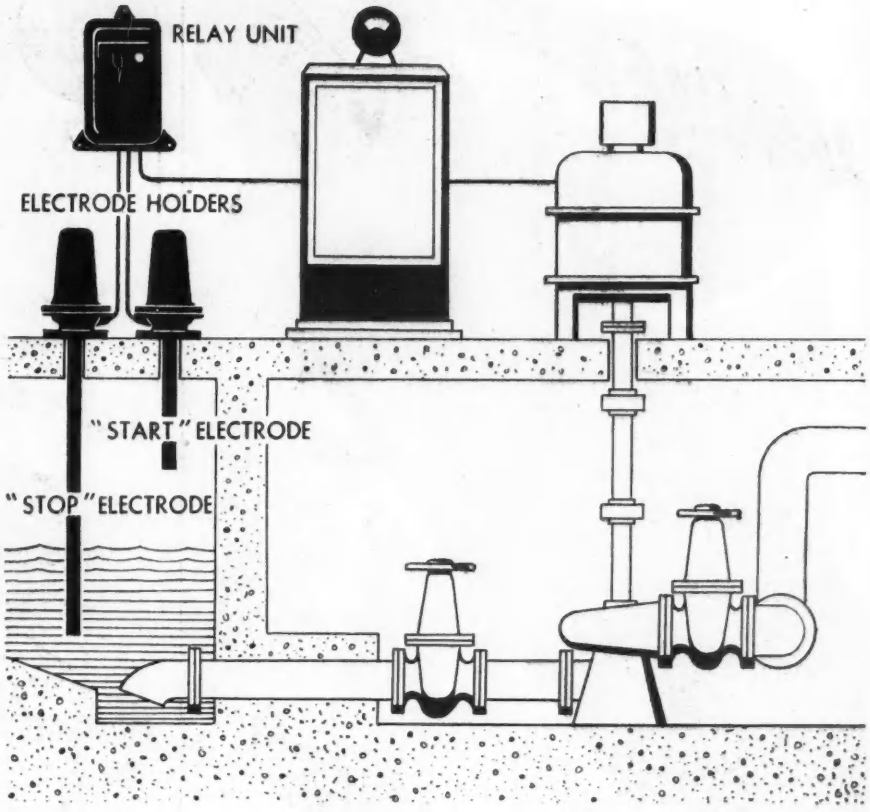

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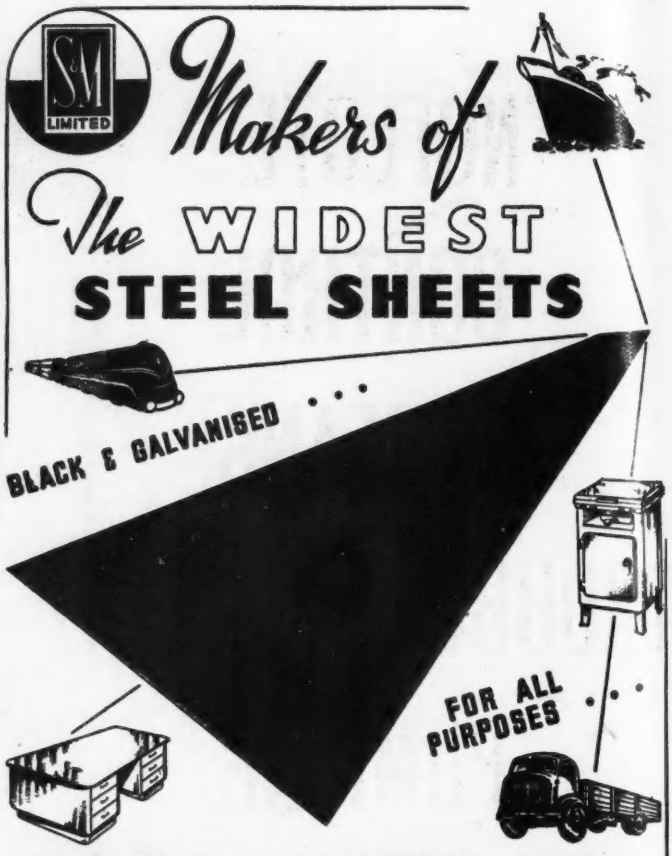

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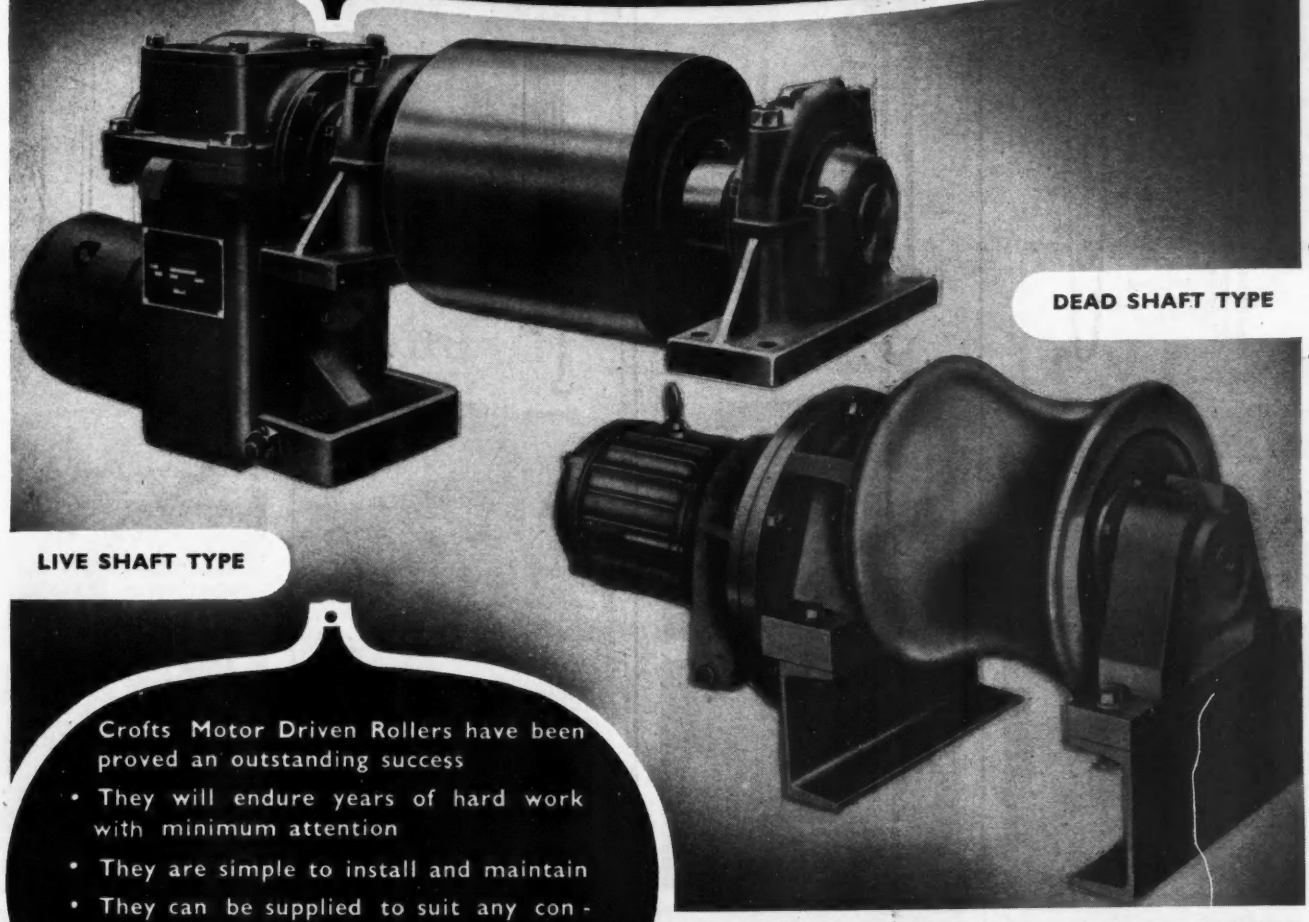

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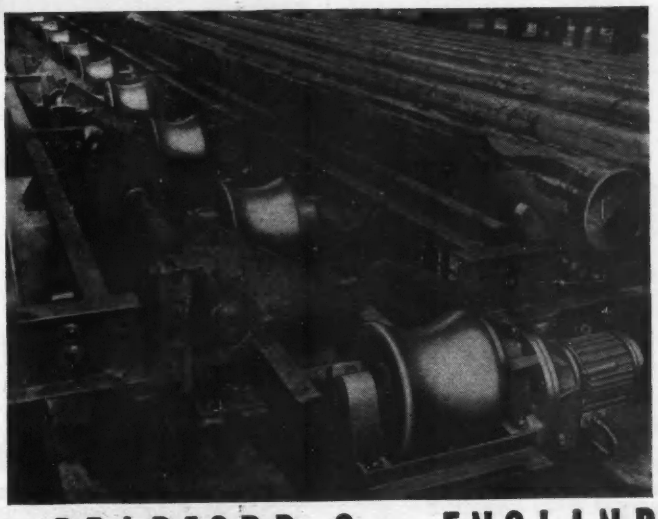

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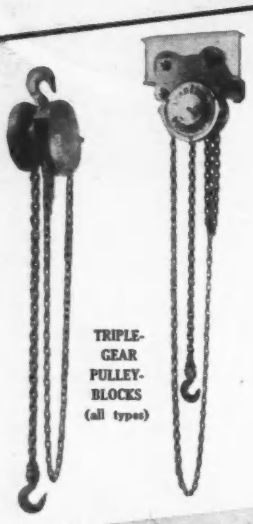

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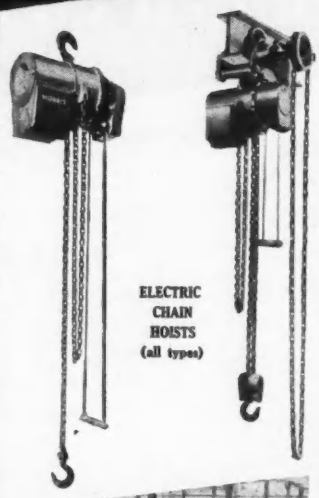

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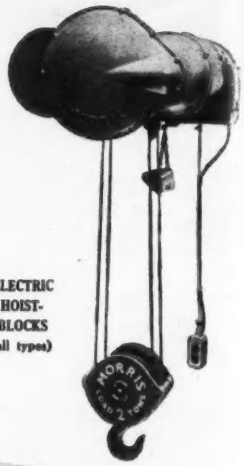

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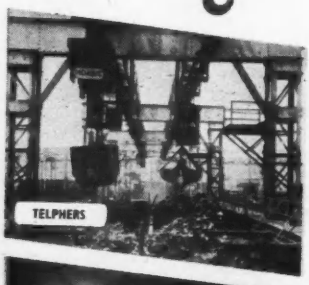

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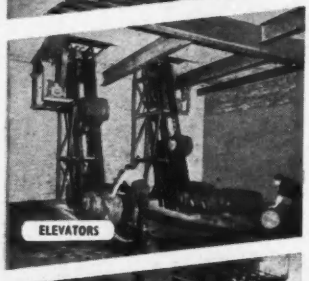

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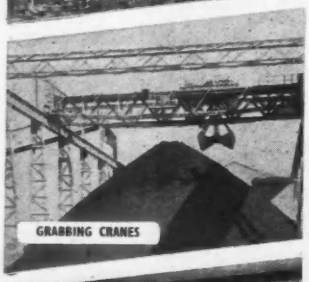

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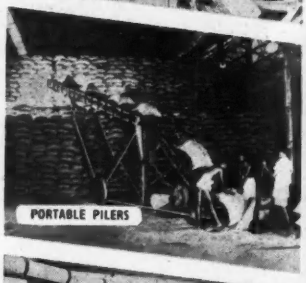

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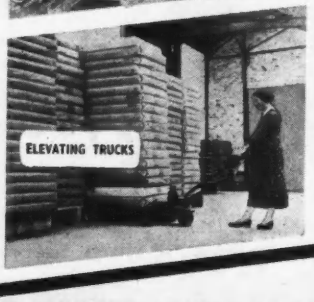

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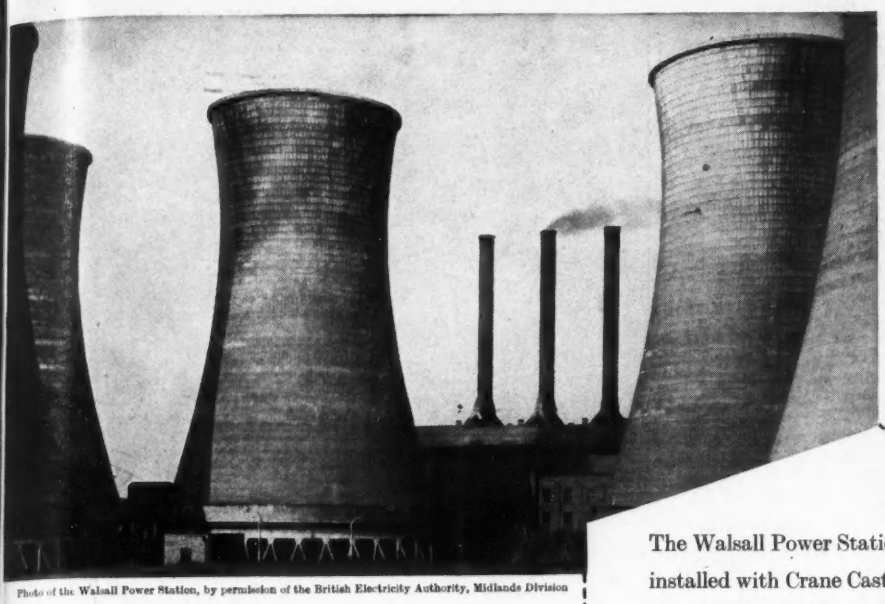
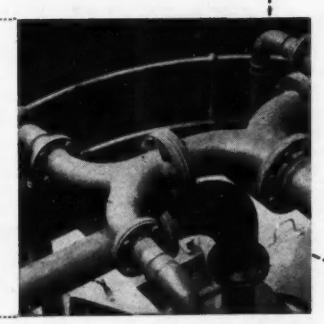


Photo of the Walsall Power Station, by permission of the British Electricity Authority, Midlands Division

Once again, fittings by Crane

The Walsall Power Station is installed with Crane Cast Iron Flanged Pipe Fittings as part of its Pneumatic Surface Cleaning Plant. This plant is operated to remove surface dust. The installation of Crane materials at the Walsall Power Station is one more tribute to the excellence of Crane fittings. Wherever reliability, good design and an assurance of long life are required in industry for valves and fittings, ask Crane first.

This photograph shows the dust conveying pipe-line at the top of the container filter unit. Crane Cast Iron Flanged Pipe Fittings are used, and were supplied and installed by B.V.C. Industrial Constructions Ltd., Head Office, Leatherhead, Surrey.



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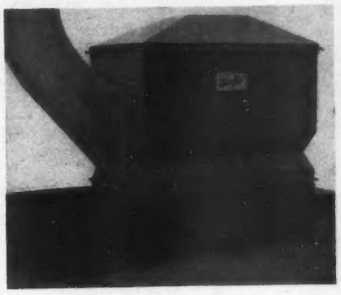

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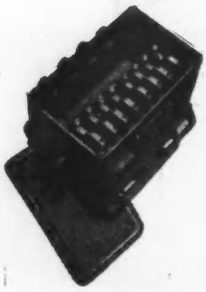

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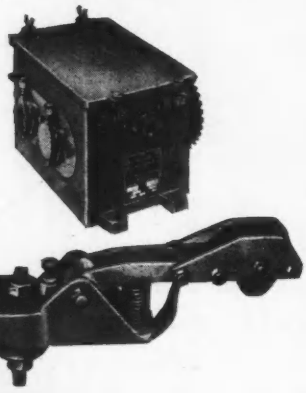

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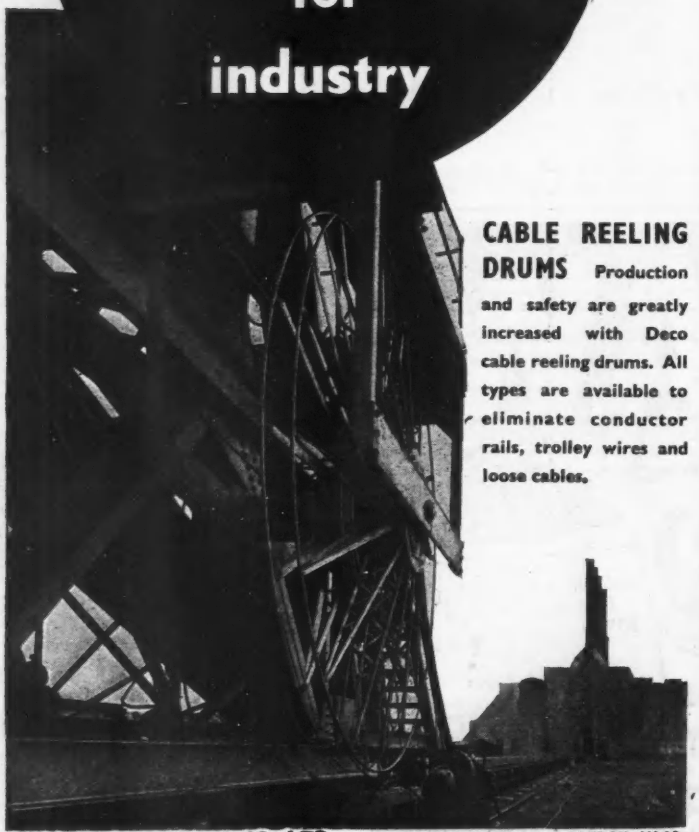

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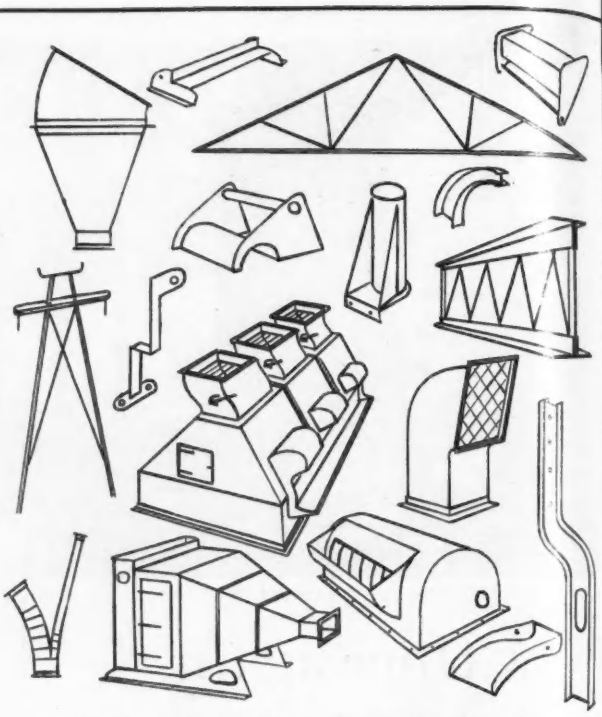

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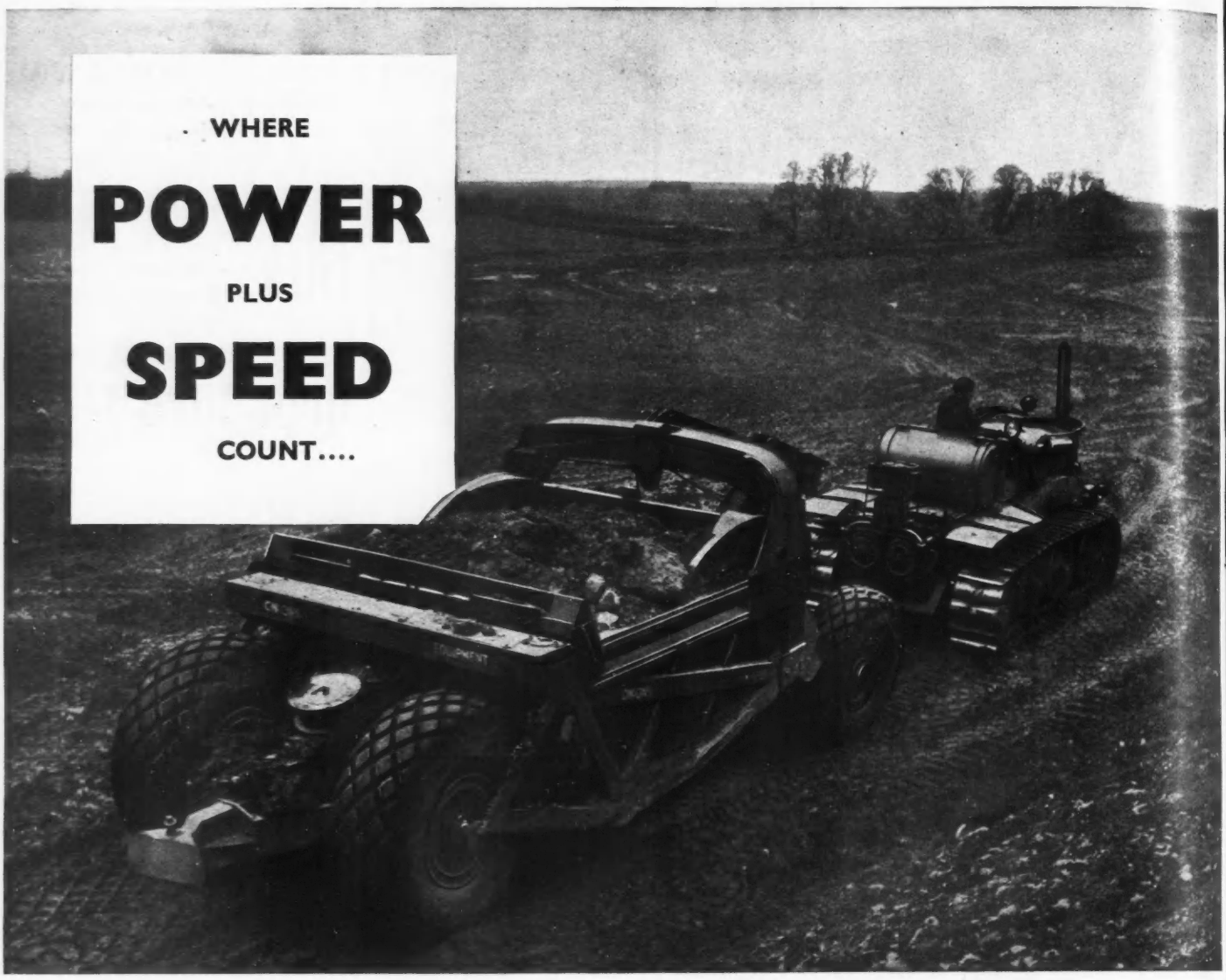

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Left: The VR·180 equipped with the Vickers Hydraulic Dozer VUHD·180.

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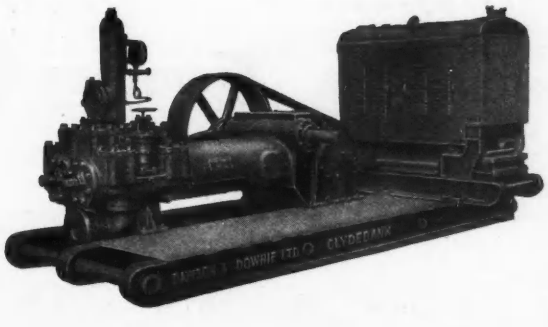

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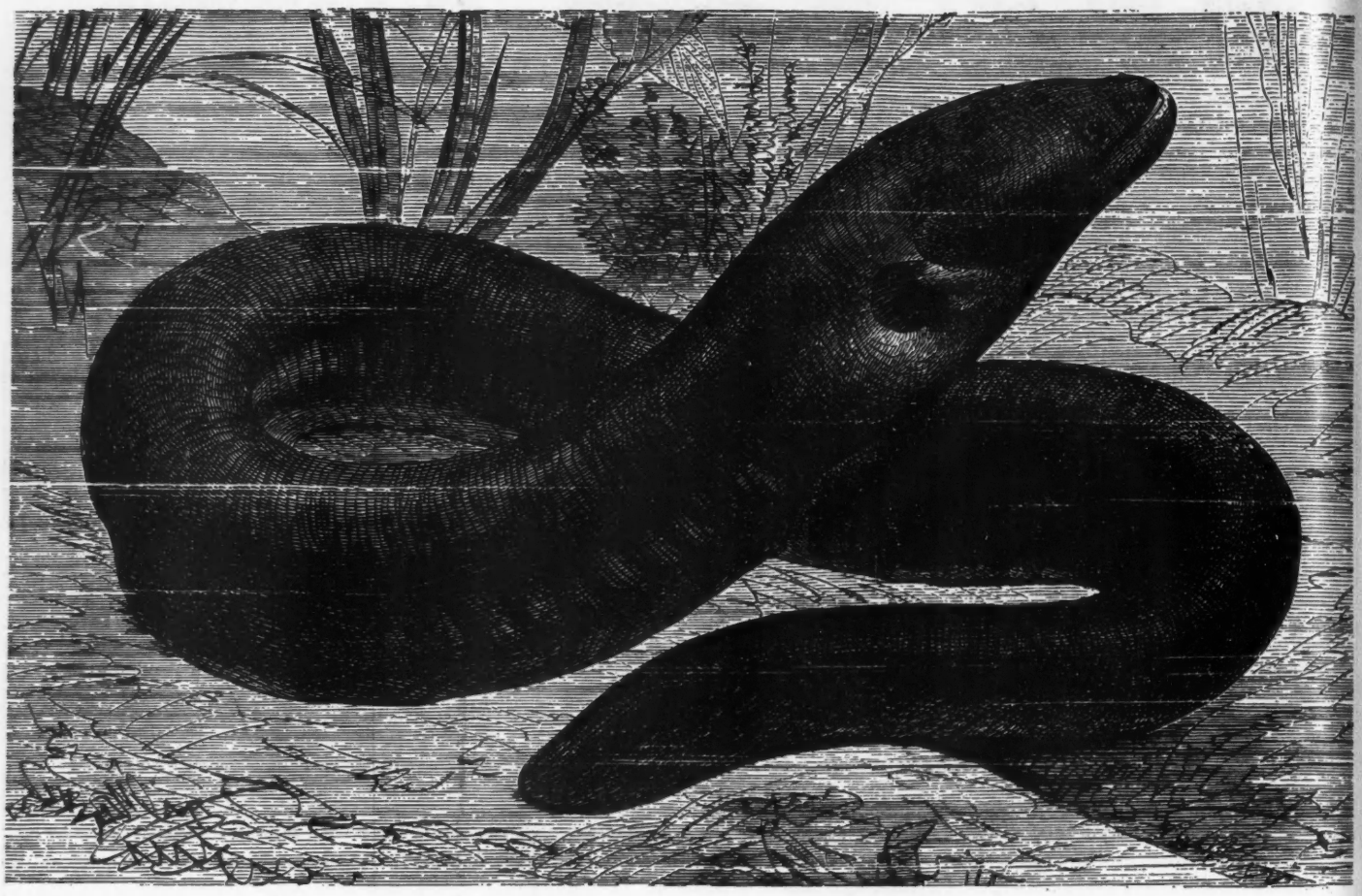

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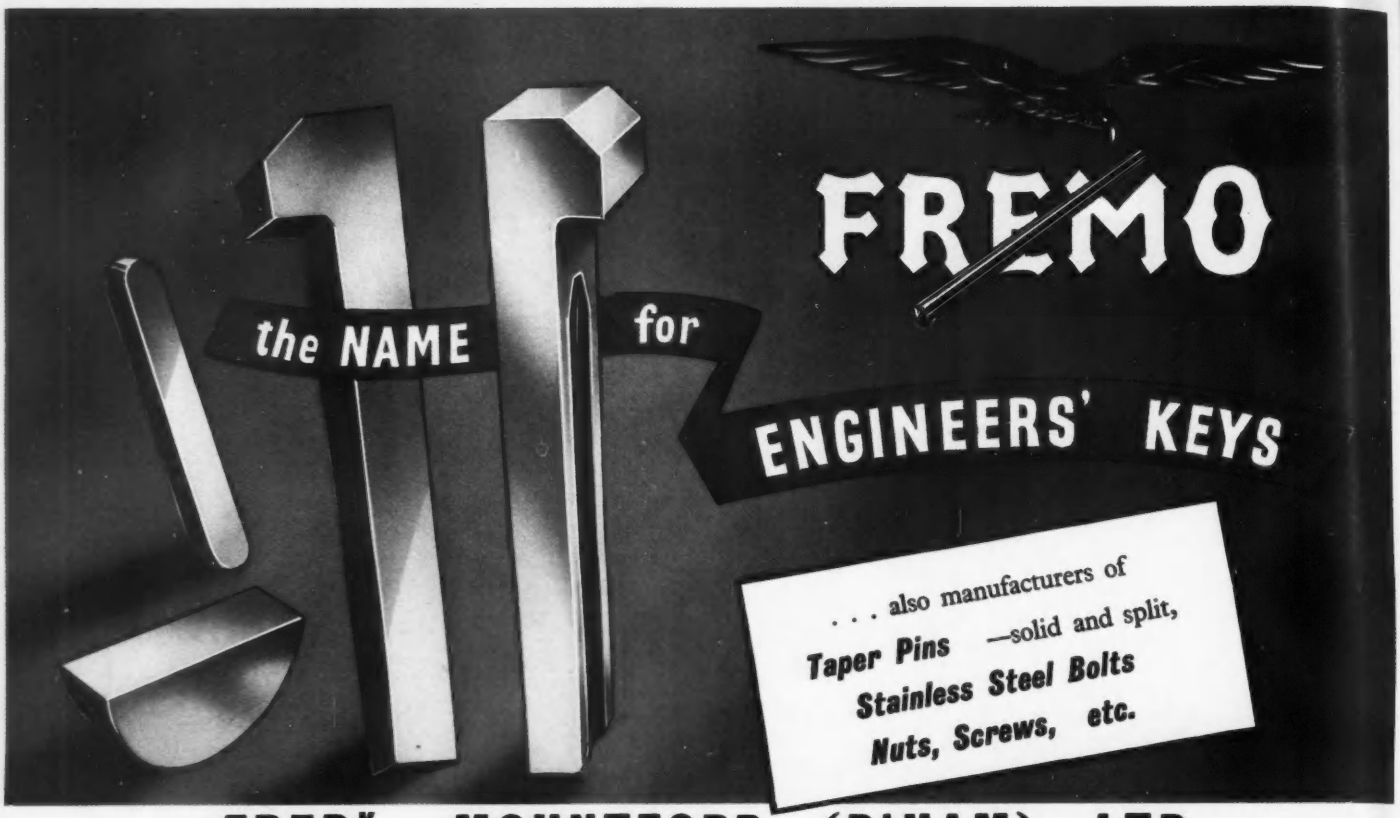

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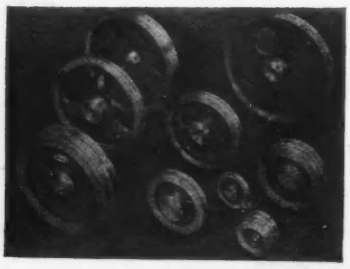

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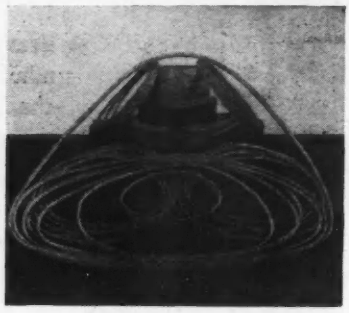

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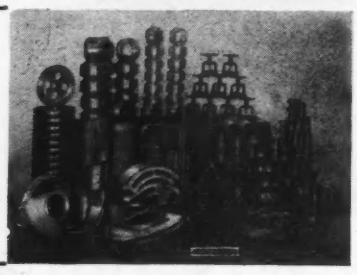

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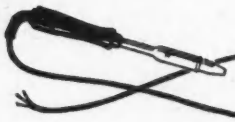

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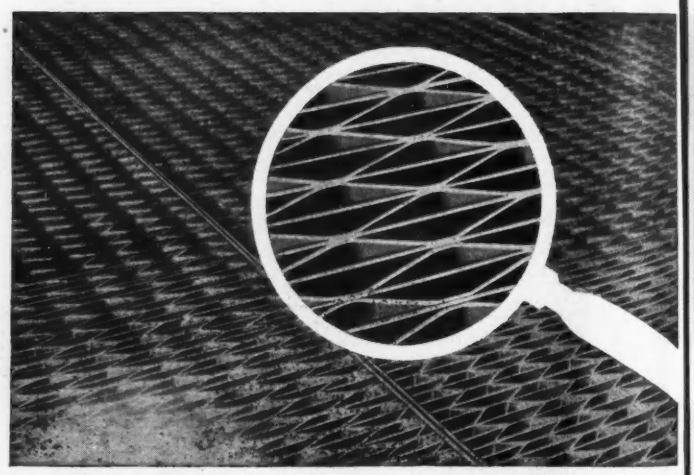

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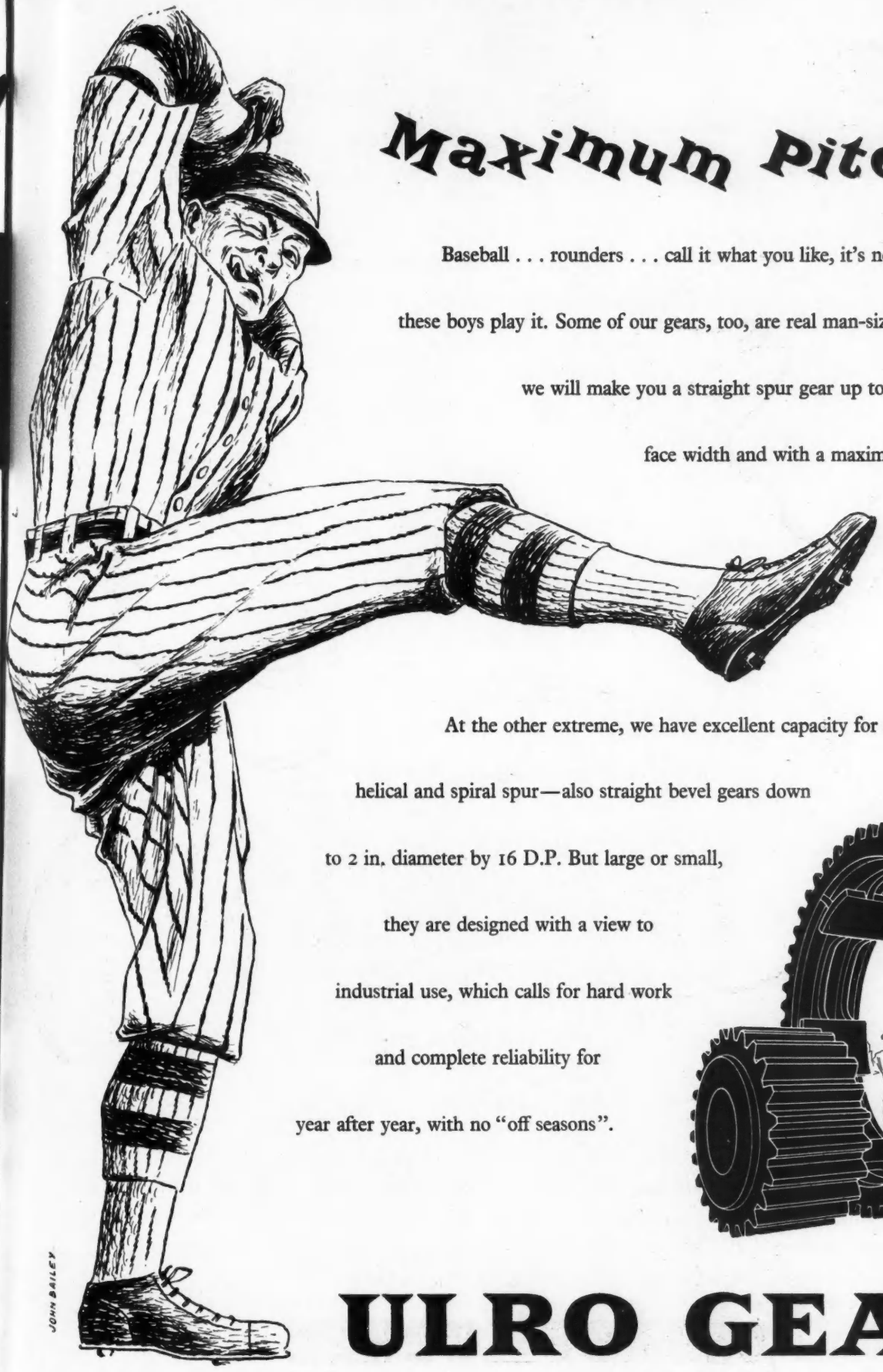

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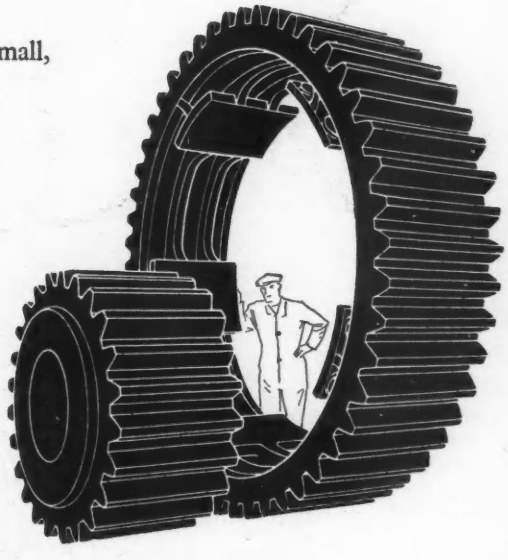

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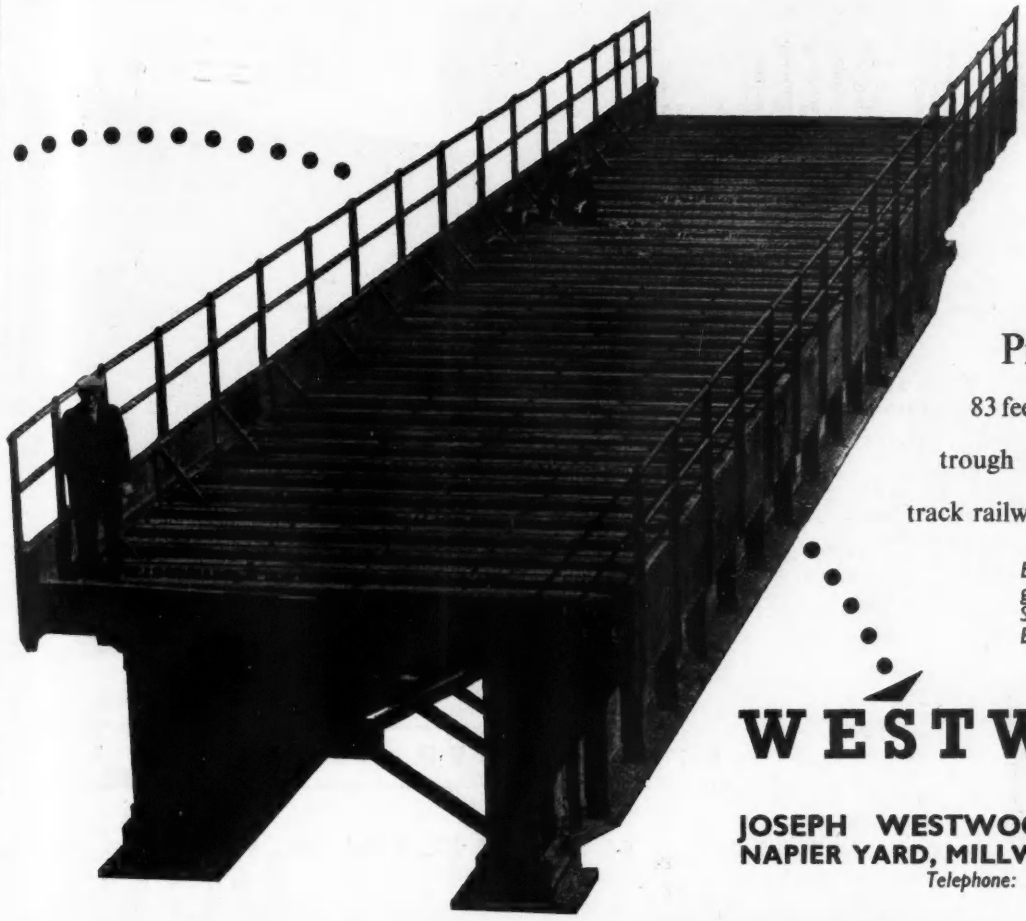

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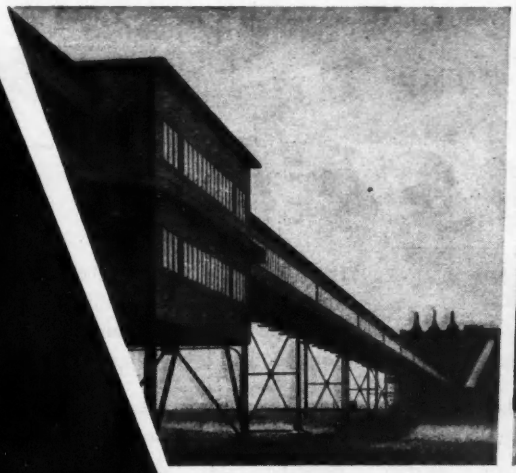

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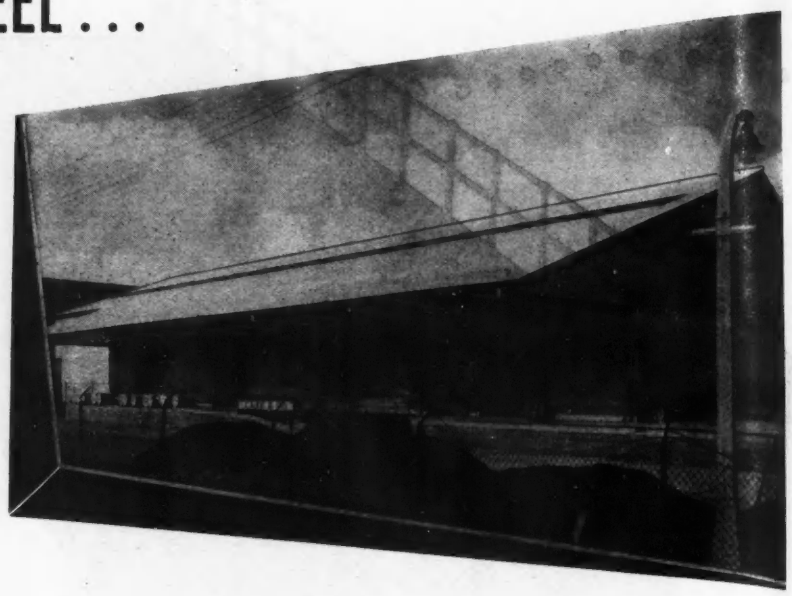

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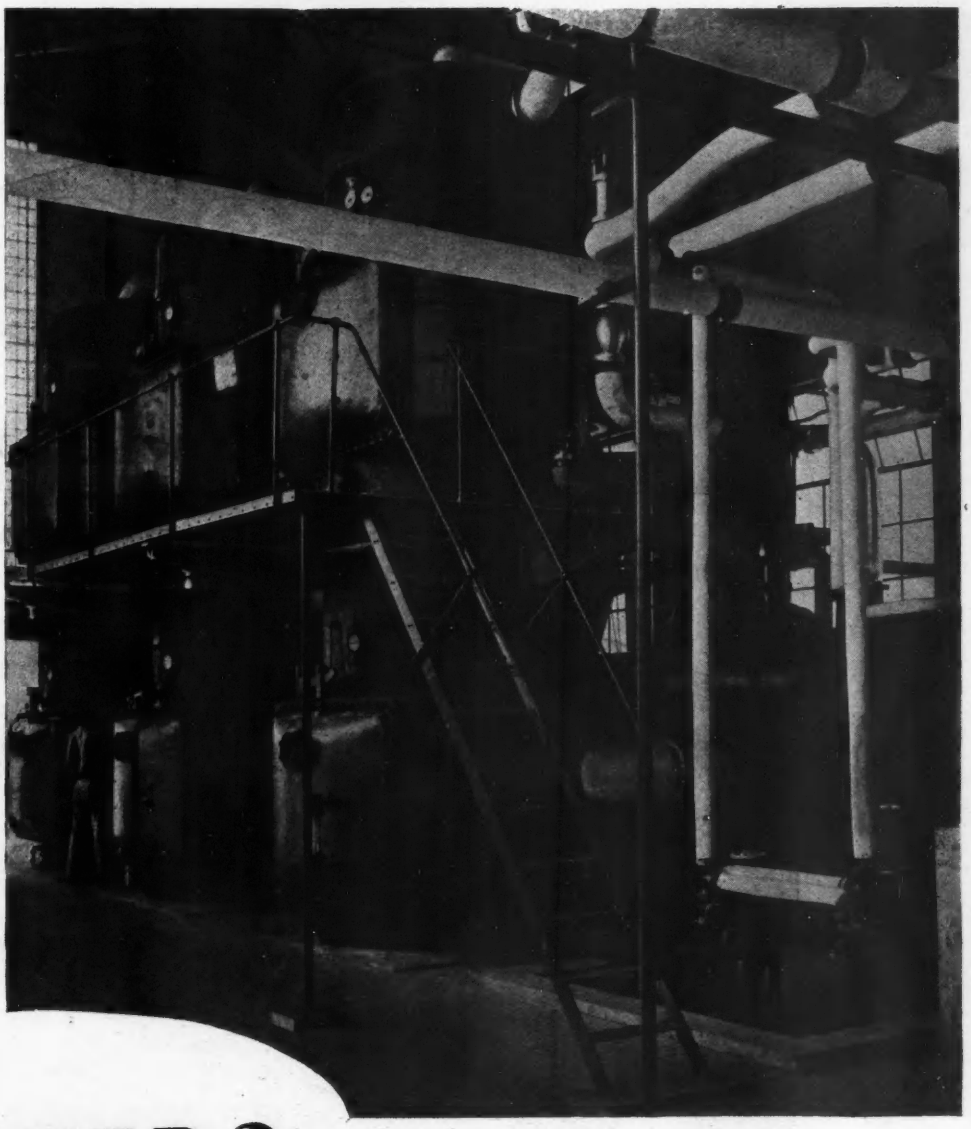

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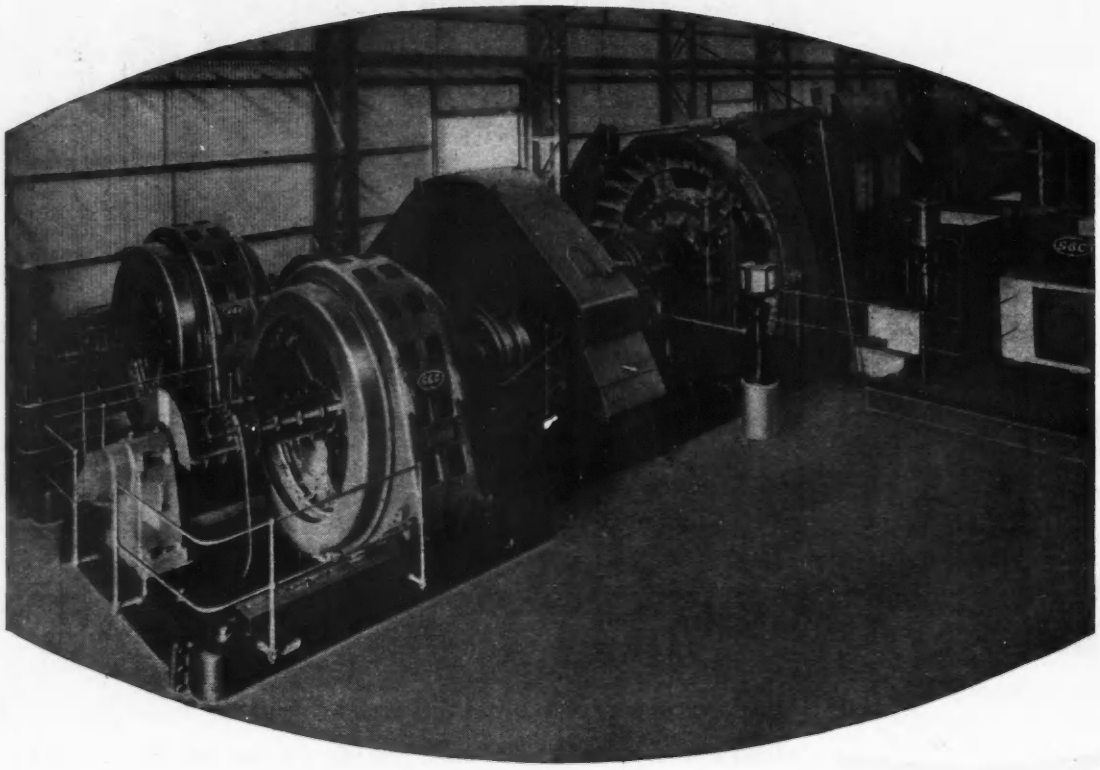

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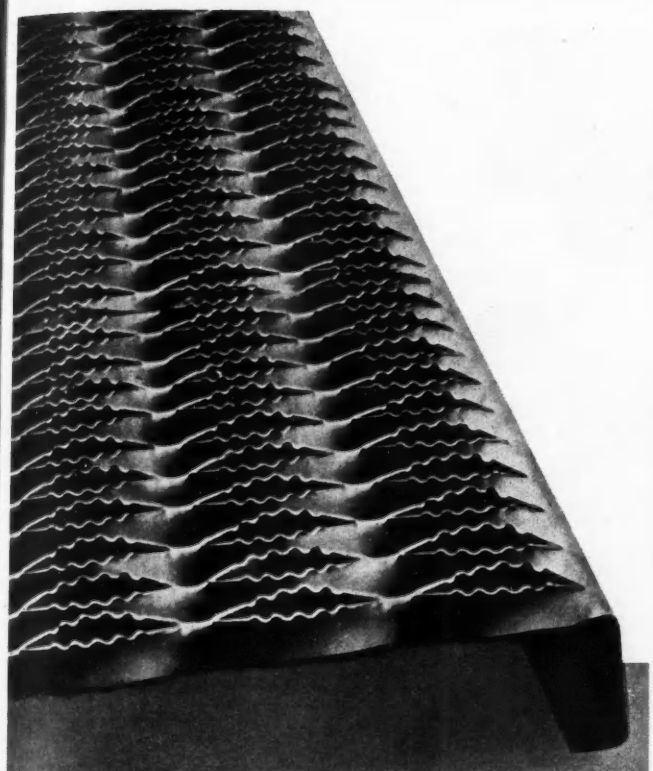

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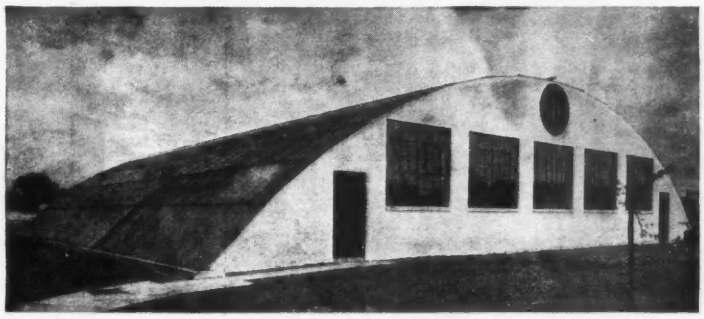

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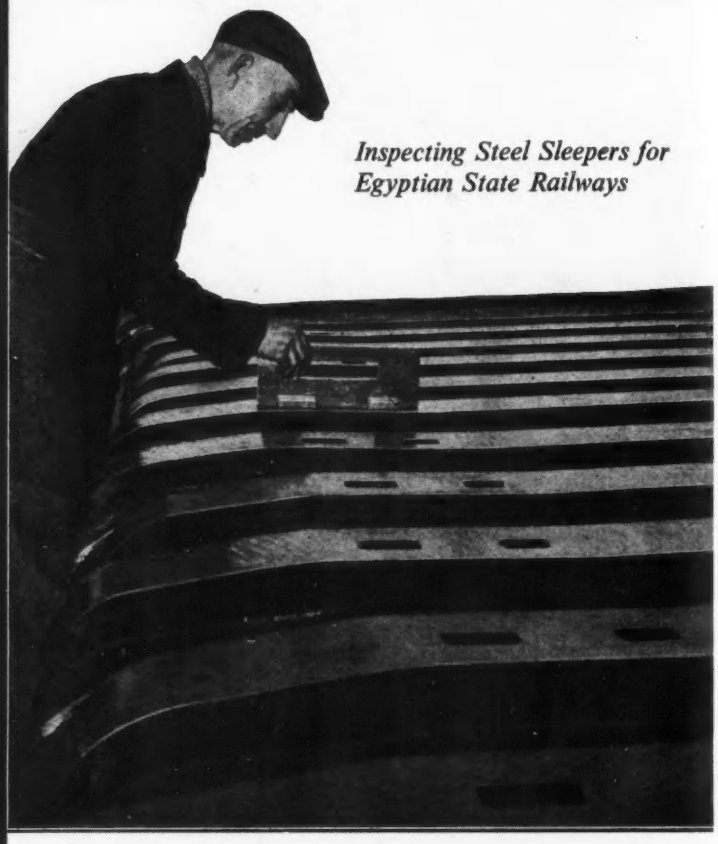

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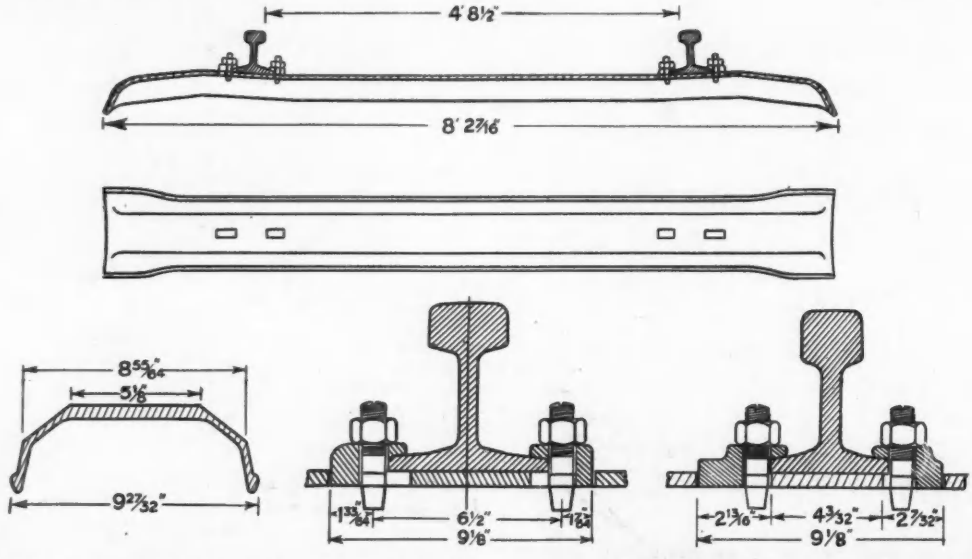

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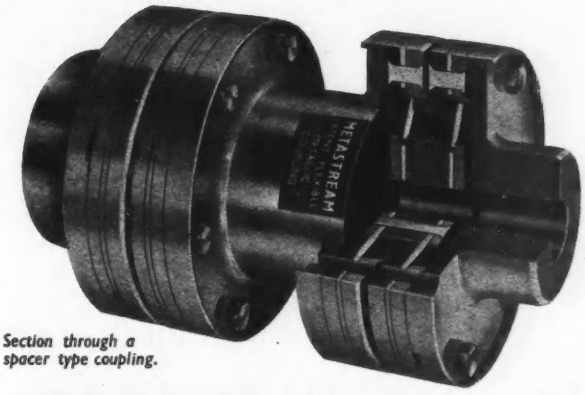

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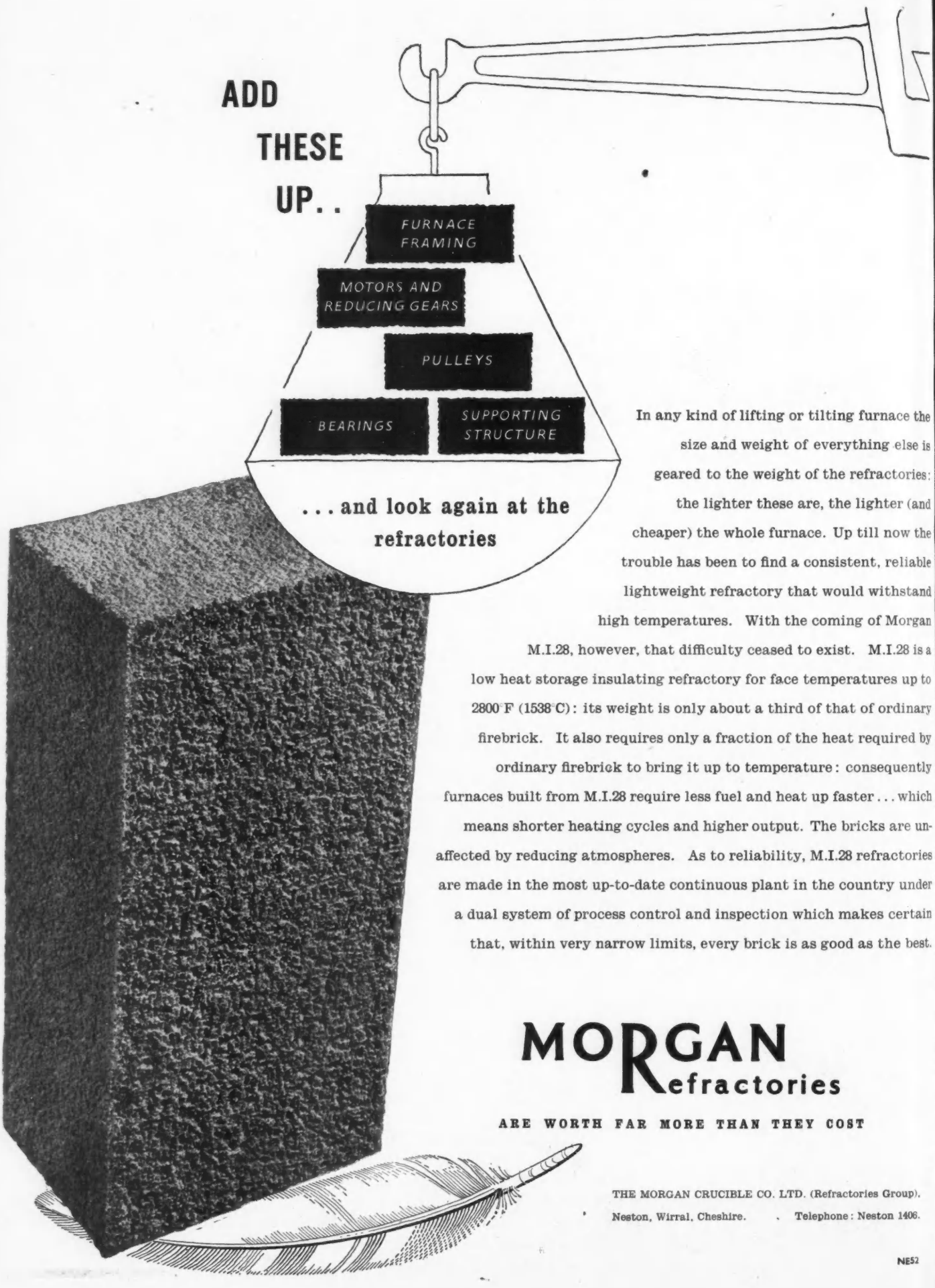

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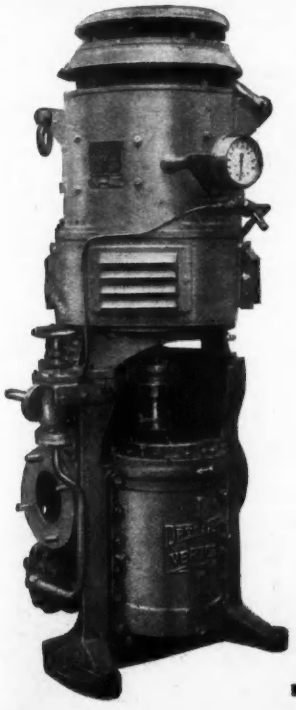

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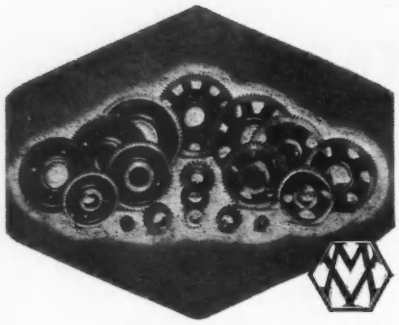

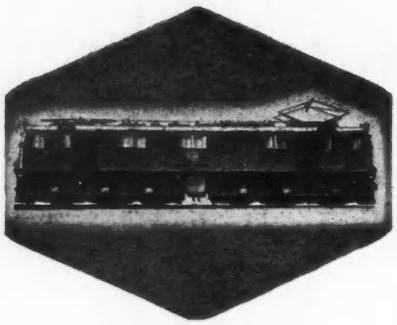

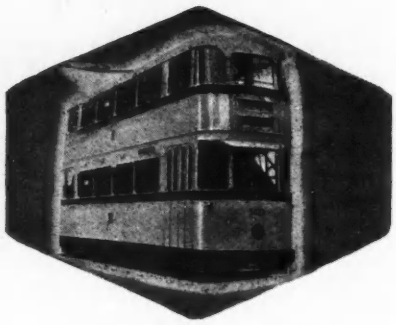

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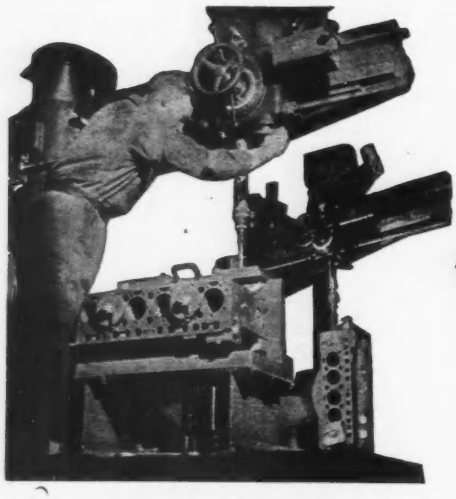

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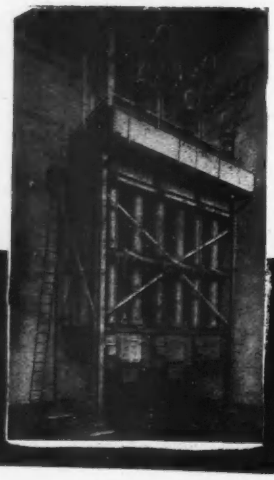

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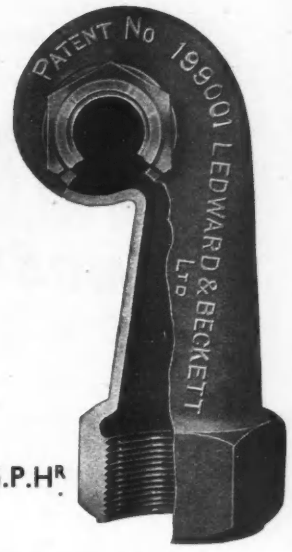

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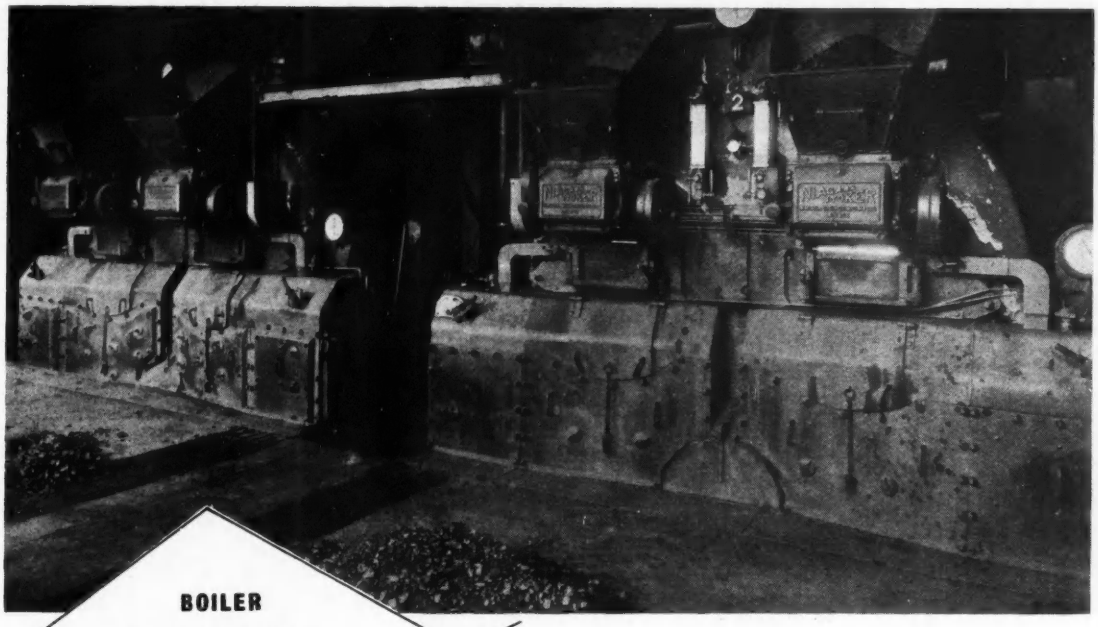

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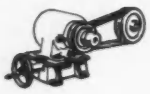
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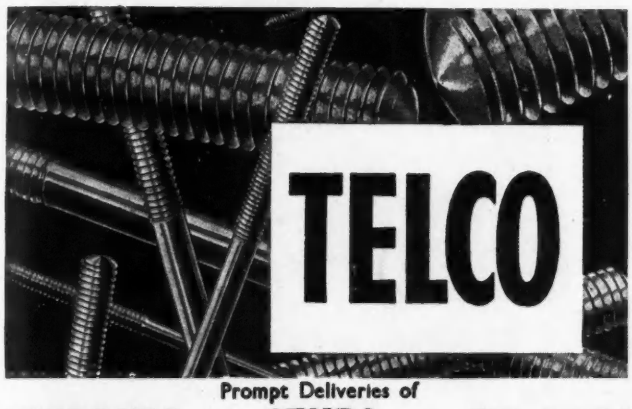

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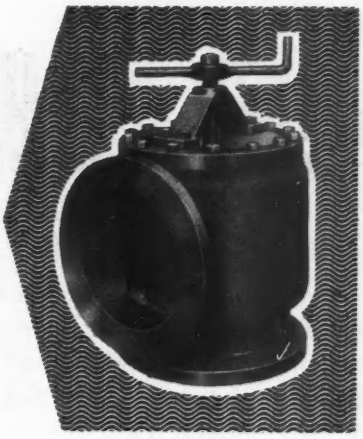

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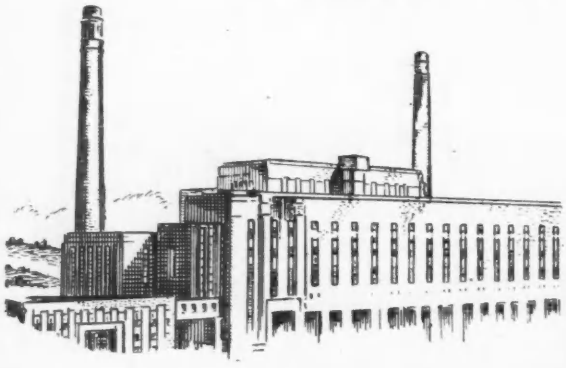

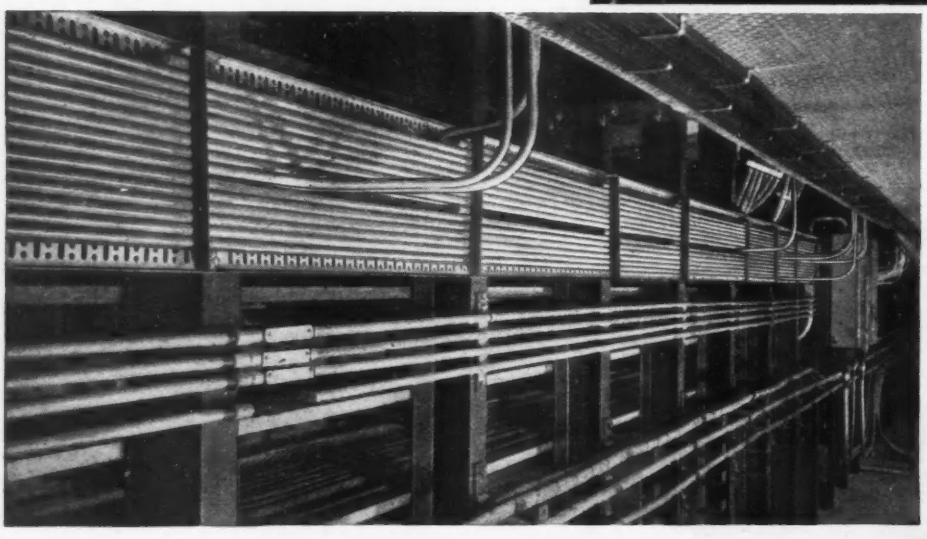

Photographs taken at Stourport 'B' Generating Station.

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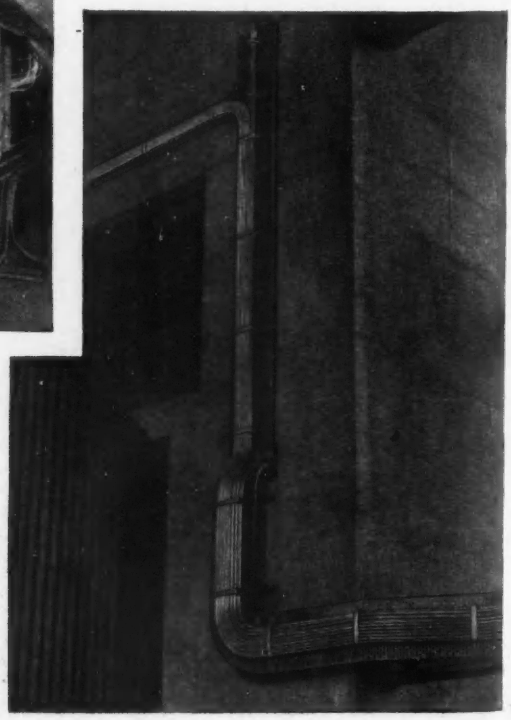

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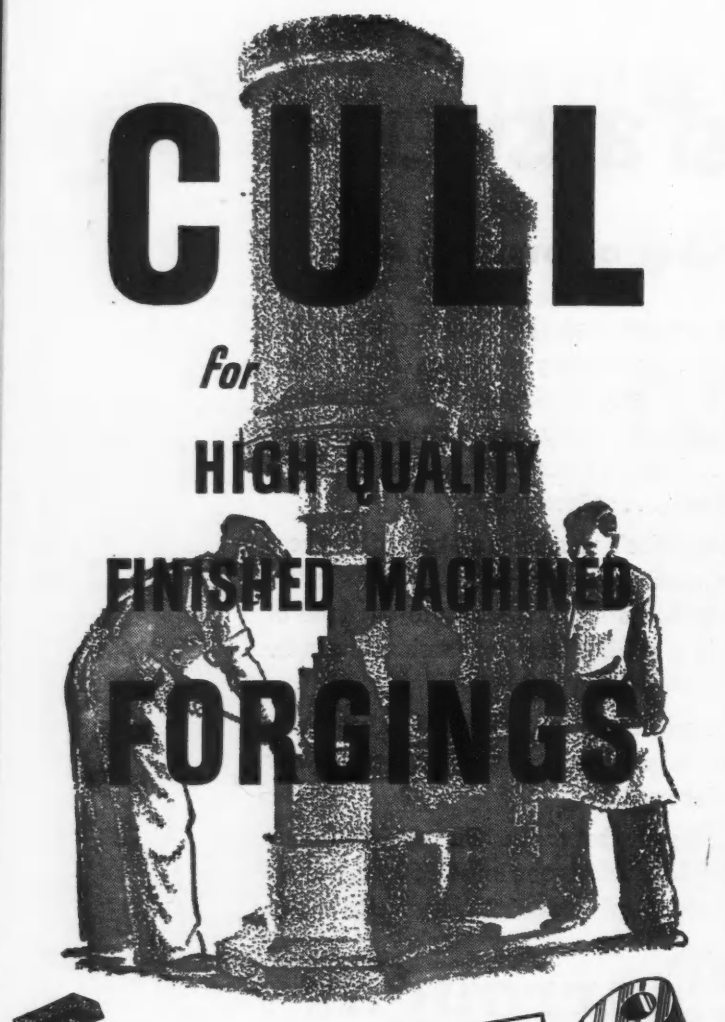

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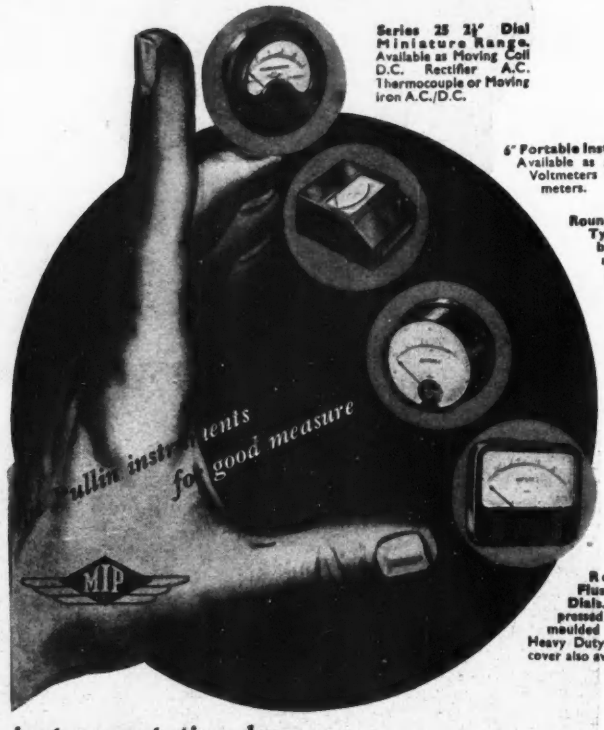
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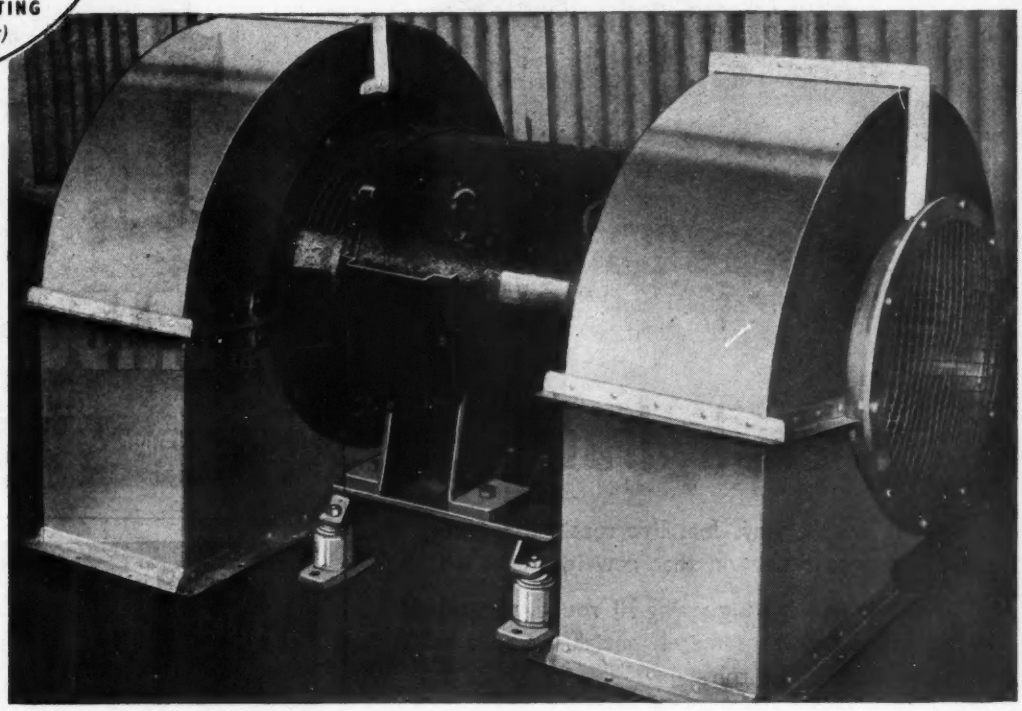
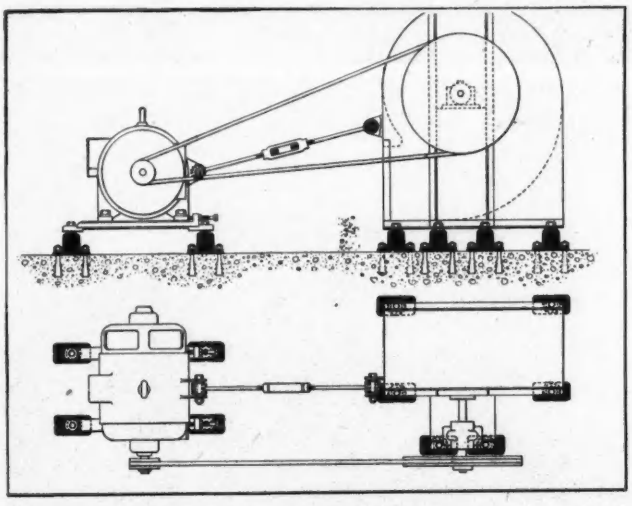


Pre-installation photograph of a ventilating unit supported on Silentbloc anti-vibration mountings. The mountings are fitted into pedestal adaptors. Photograph by courtesy of Norsk Elektrisk & Brown Boveri A/S., Oslo.



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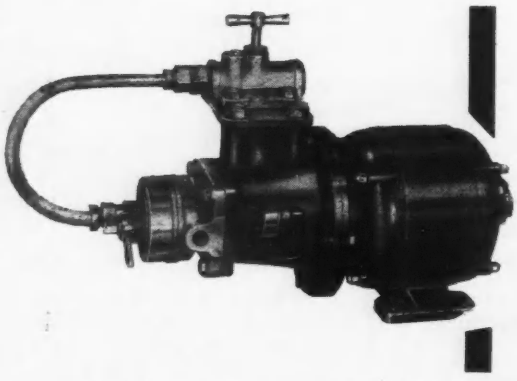

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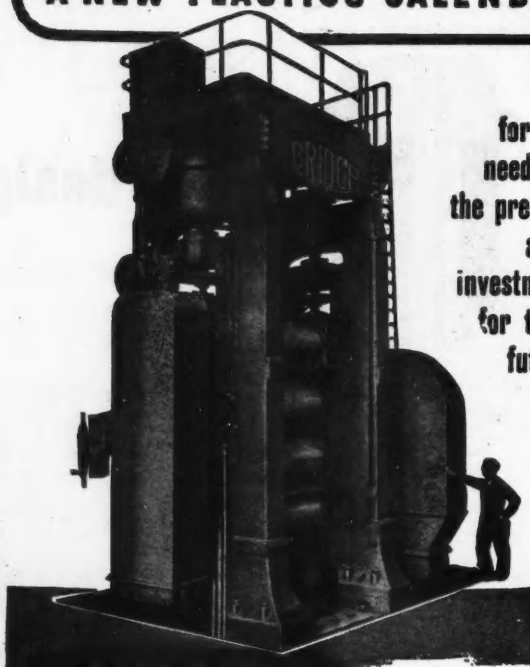

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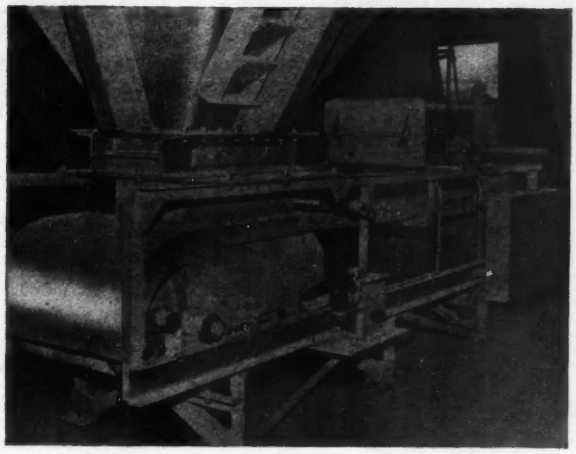

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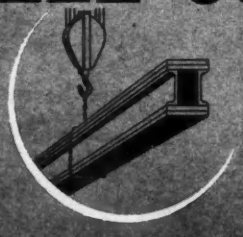

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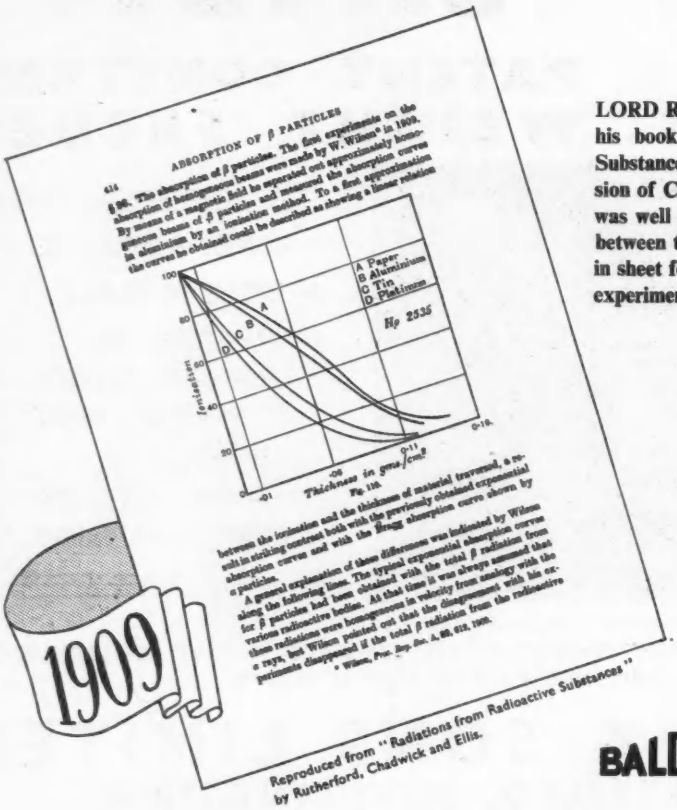
1909
ABSORPTION OF β PARTICLES
§ 96. The absorption of β particles. The first experiments on the absorption of homogeneous beams were made by W. Wilson* in 1909. By means of a magnetic field he separated out approximately homogeneous beams of β particles and measured the absorption curves in aluminium by an ionisation method. To a first approximation the curves he obtained could be described as showing a linear relation
A Paper
B Aluminium
C Tin
D Platinum
Hp 2535
Ionisation
Thickness in gms/cm²
Fig. 118.
between the ionisation and the thickness of material traversed, a result in striking contrast both with the previously obtained exponential absorption curves and with the Bragg absorption curve shown by α particles.
A general explanation of these differences was indicated by Wilson along the following lines. The typical exponential absorption curves for β particles had been obtained with the total β radiation from various radioactive bodies. At that time it was always assumed that these radioactive bodies were homogeneous in velocity from analogy with the α rays, but Wilson pointed out that the disagreement with his experiments disappeared if the total β radiation from the radioactive
* Wilson, Proc. Roy. Soc., A, 82, 232, 1909.
Reproduced from "Radiations from Radioactive Substances" by Rutherford, Chadwick and Ellis.

1954

LORD RUTHERFORD, as the page from his book "Radiations from Radioactive Substances" (reproduced by kind permission of Cambridge University Press) shows, was well aware of the practical connection between the absorption of beta rays and the weight per unit area of material in sheet form. The graph shows, in a concise form, the result of W. Wilson's experiments carried out as long ago as 1909.

This information remained in cold storage, so to speak, as far as its industrial use was concerned until, with the advent of the atomic pile, radioactive isotopes could be produced in a handy, inexpensive form.

The Baldwin Instrument Co. Ltd. began making instruments for the measurement of X-ray as long ago as 1937 and was indeed, for many years, the only British concern doing so.

We were, therefore, in a peculiarly favourable position to make use of the new facilities afforded by radioactive isotopes and from 1949 onwards we have been largely concerned with the practical application of measuring and controlling the weight or thickness of all sorts of sheet material by means of its absorption of ionising radiation, including the whole range of beta, gamma and X-rays.

There is no cut-and-dried method that covers all cases and requirements and this is essentially a field where practical experience of the needs of the particular case counts in its satisfactory solution.

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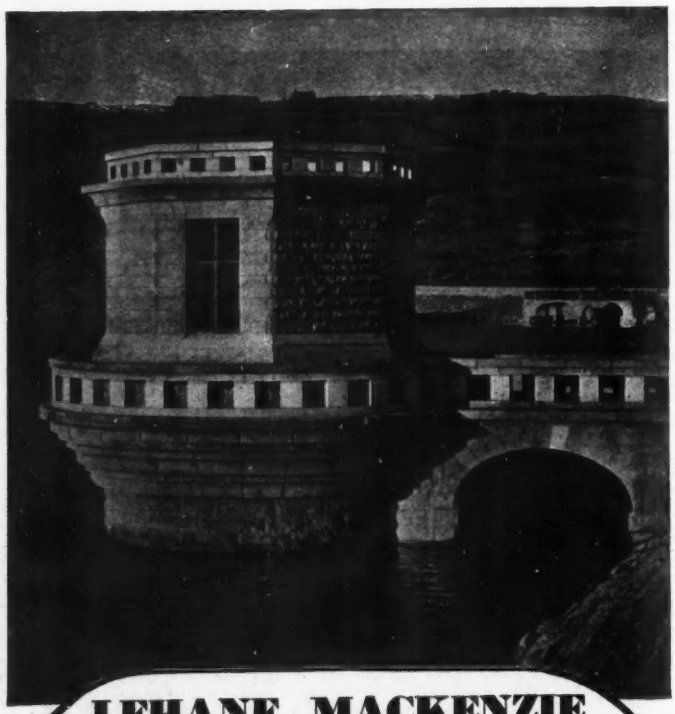

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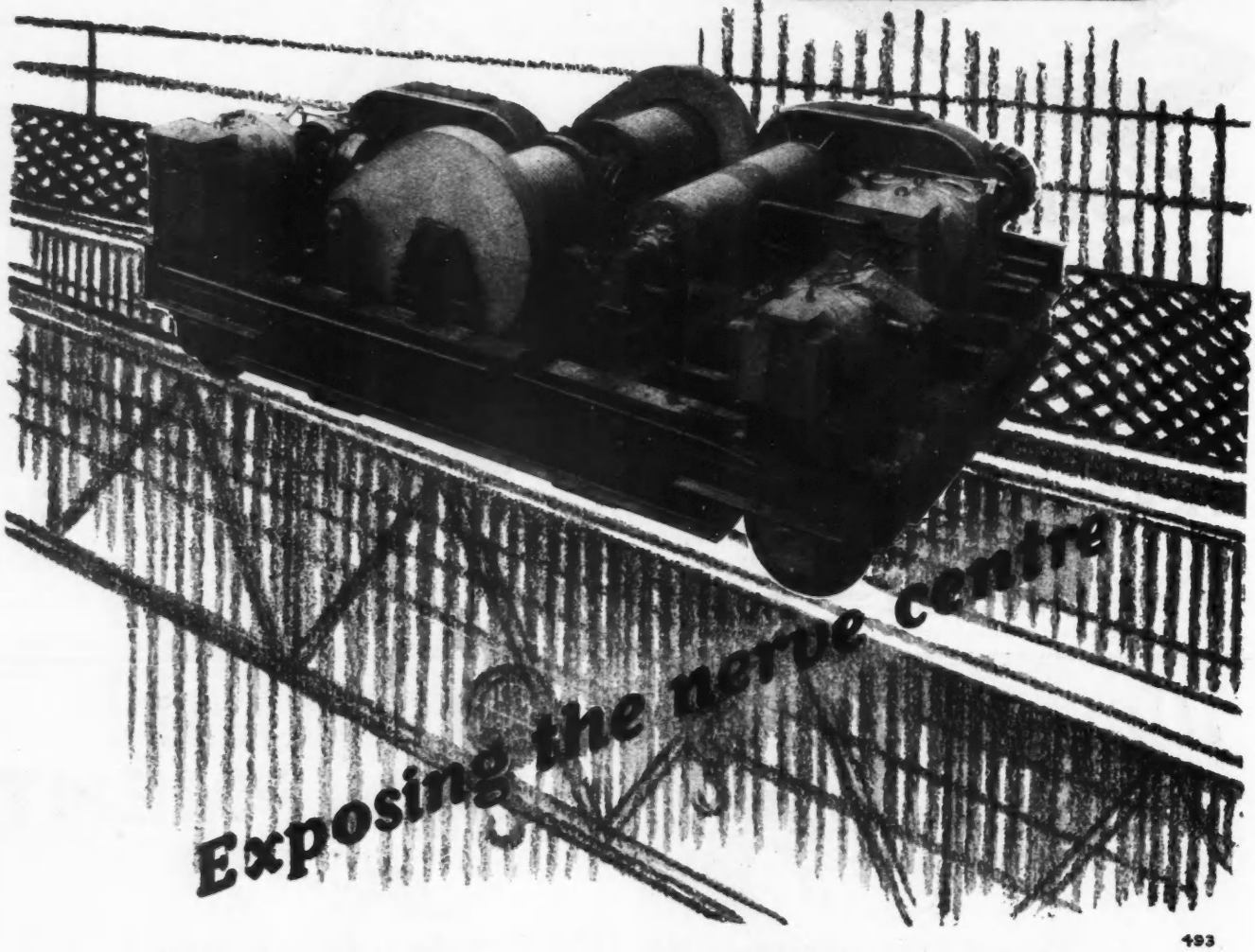

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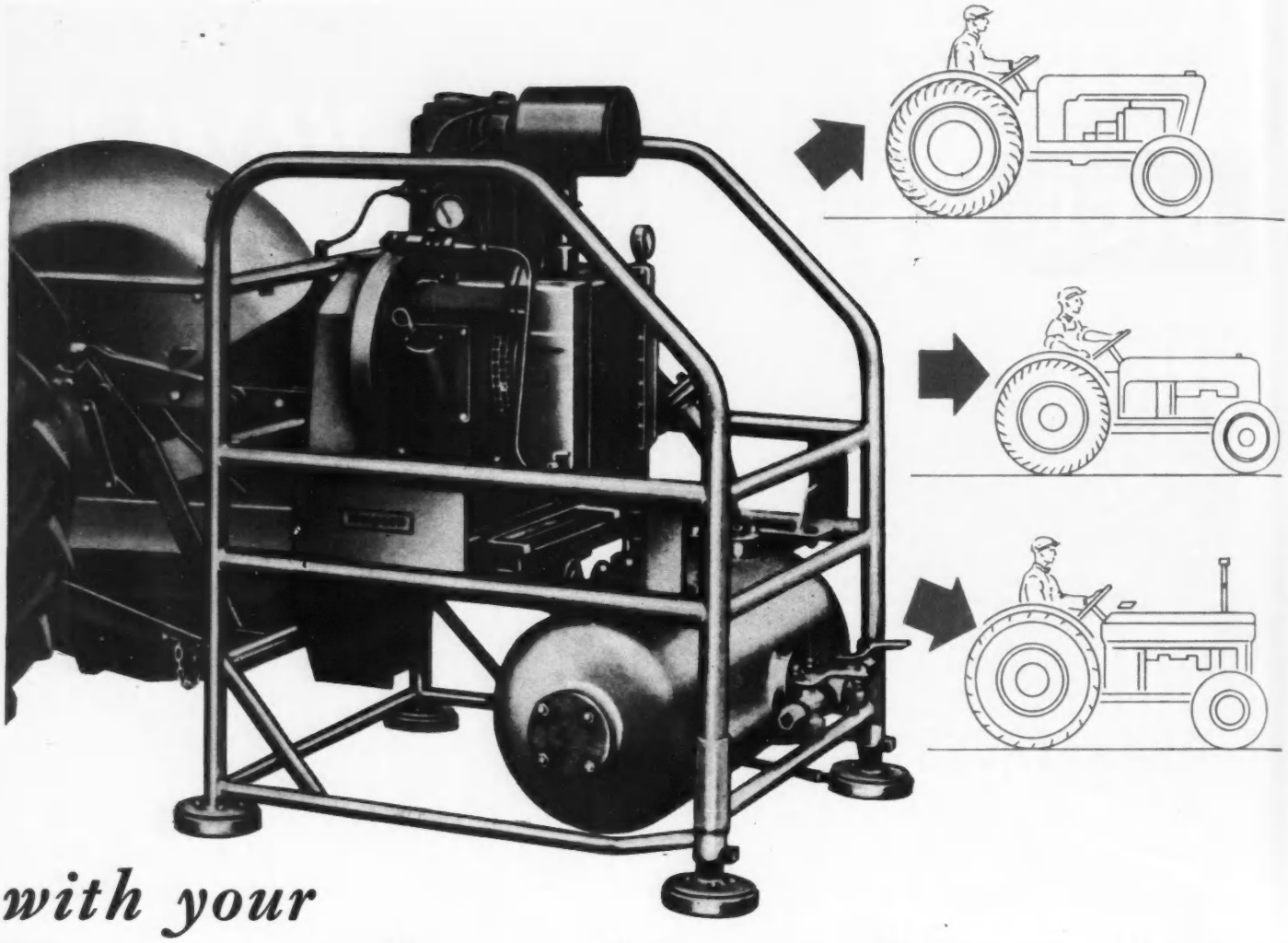

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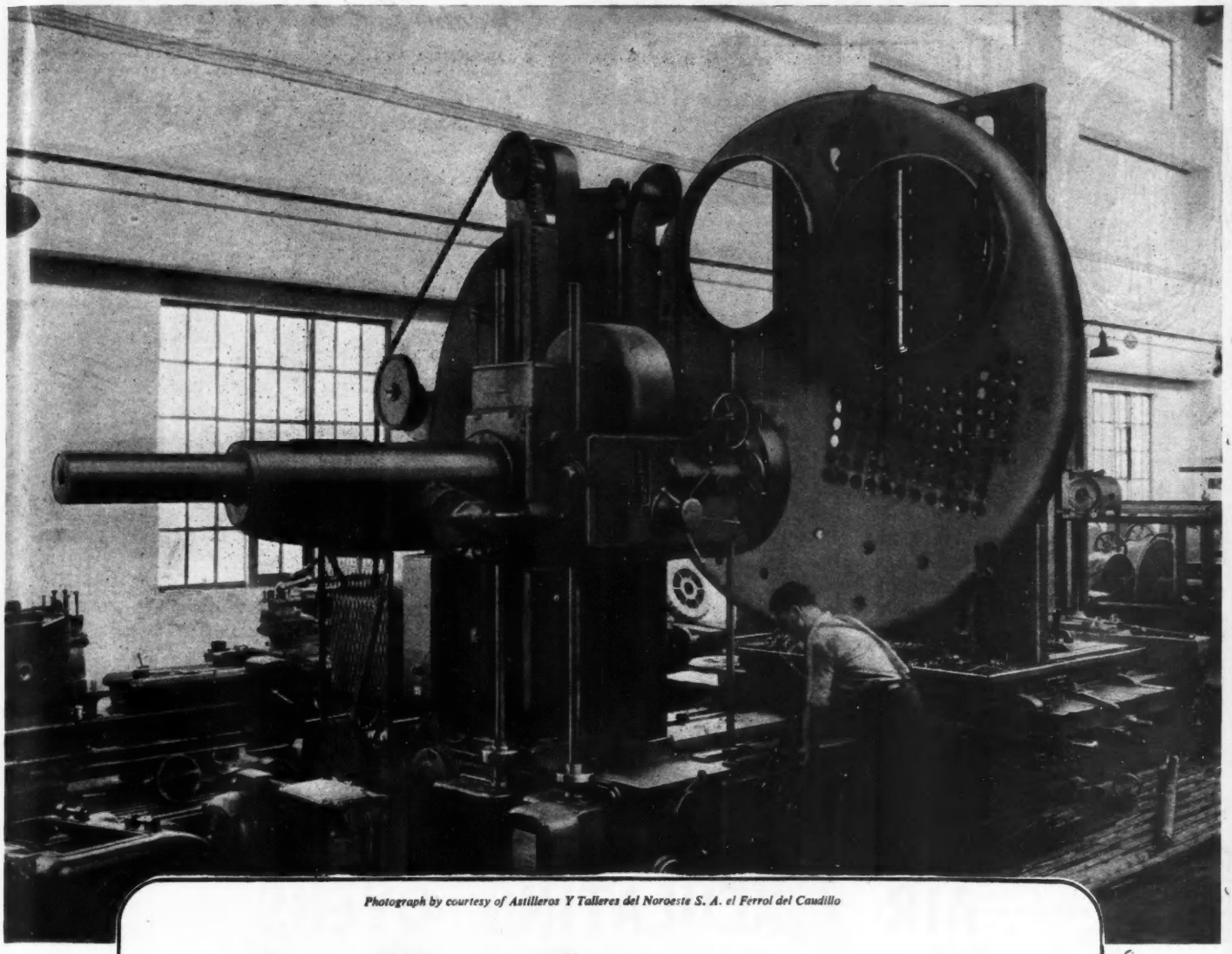

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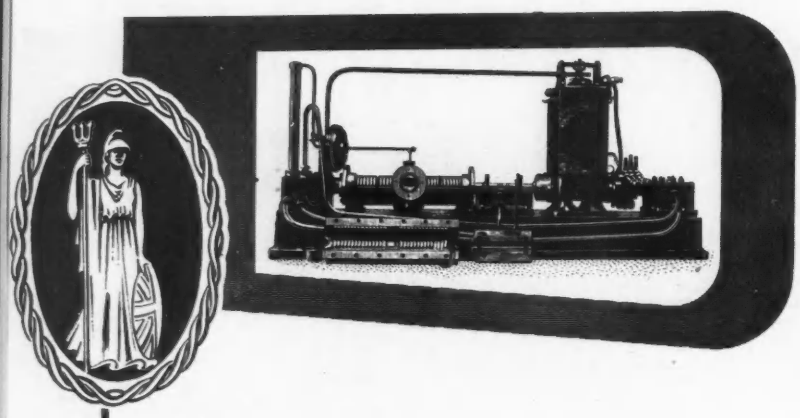

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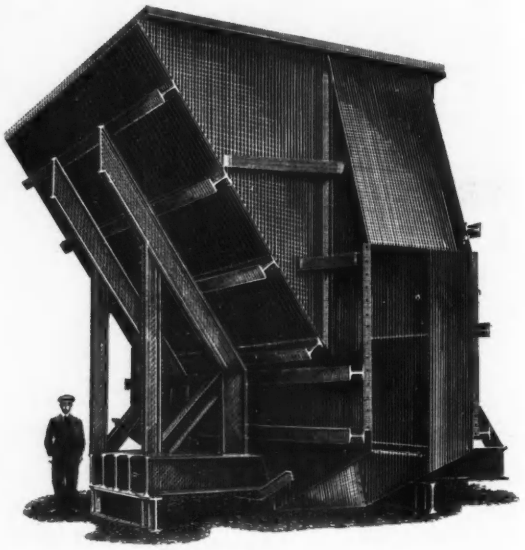

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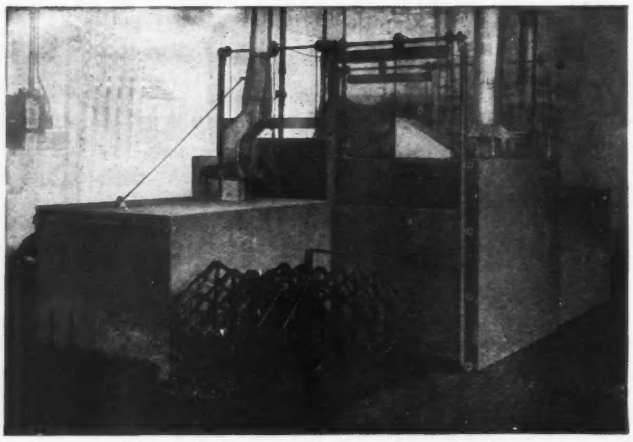

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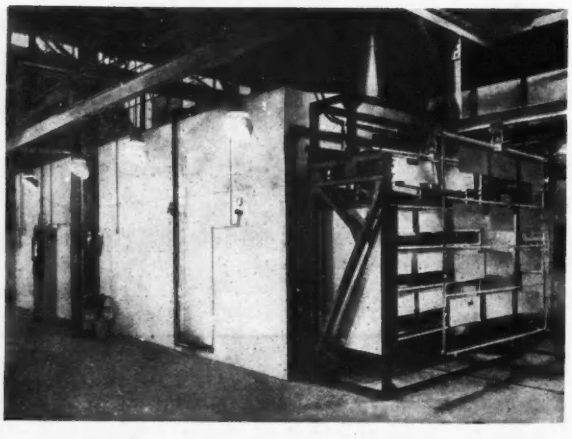

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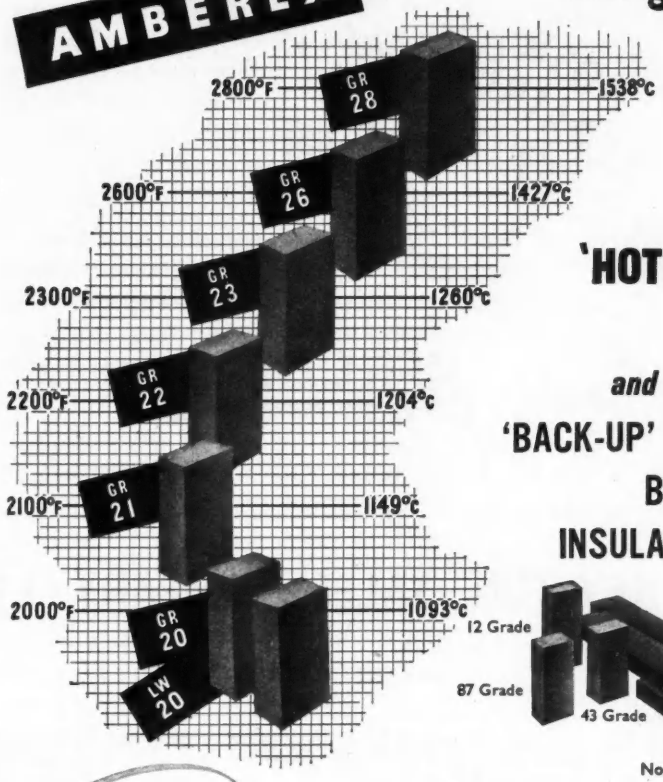

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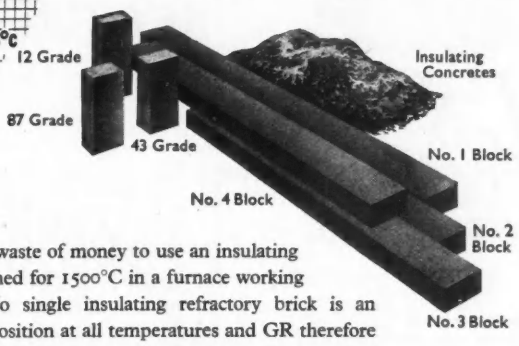

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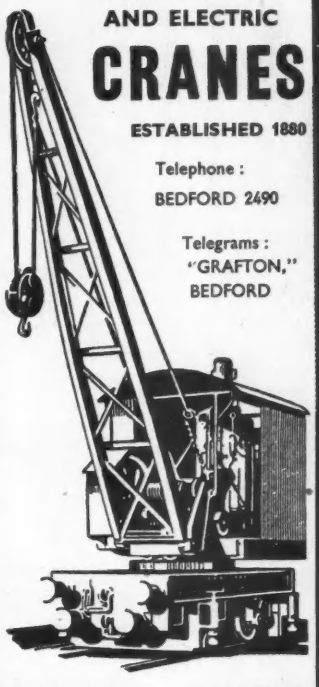

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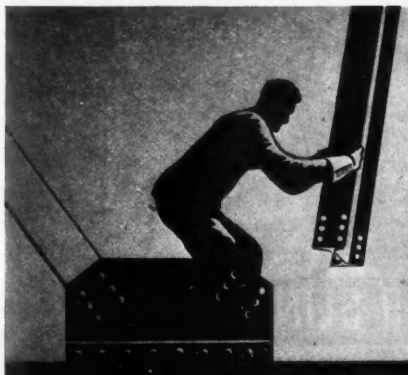

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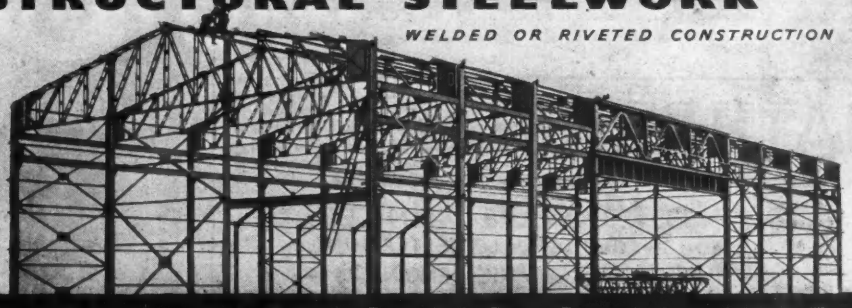

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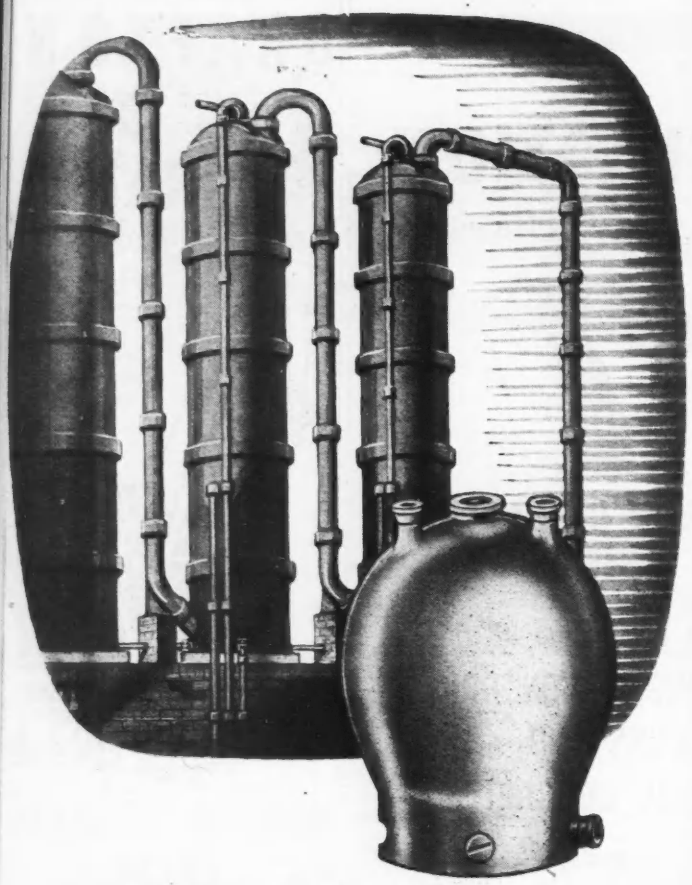

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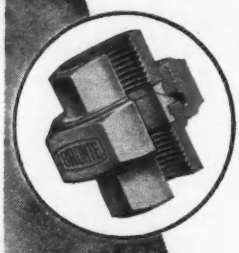

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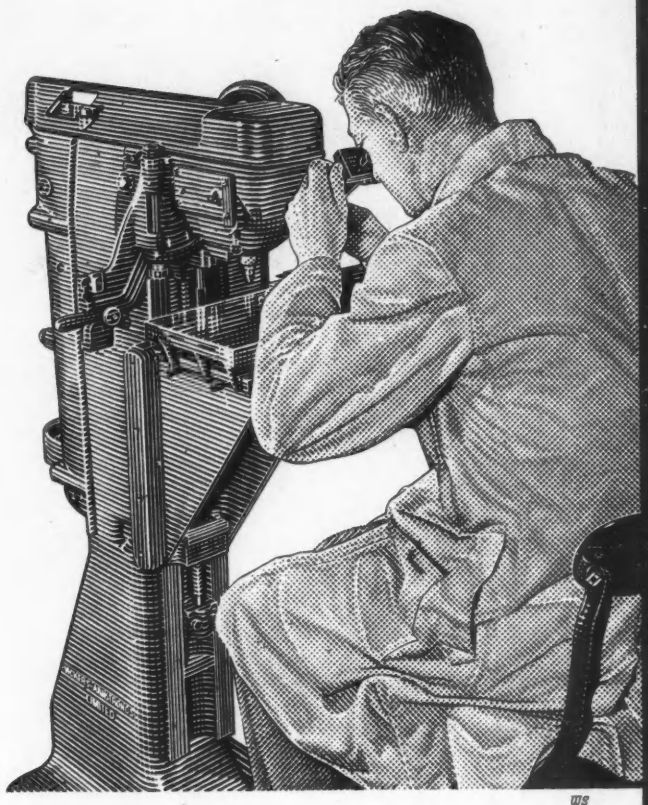

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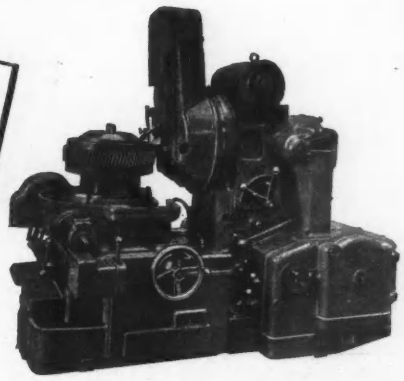

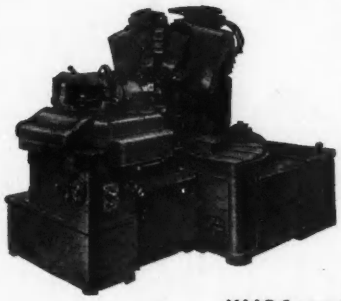

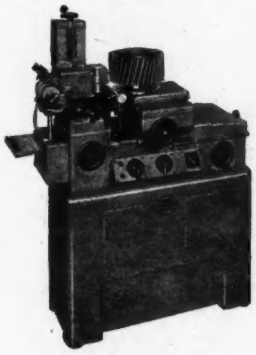

MAAG Gear Testing Machine, PH-60, inspects, measures and records tooth profile, tooth alignment, helix angle, concentricity and surface finish of tooth flanks. Capacity 23 in. dia. Can be adapted for spur and helical *internal* gears. Other **MAAG** gear testing and measuring instruments are made in various types and sizes for checking pitch, profile, centre distance and concentricity with a precision of 0.00004 in.

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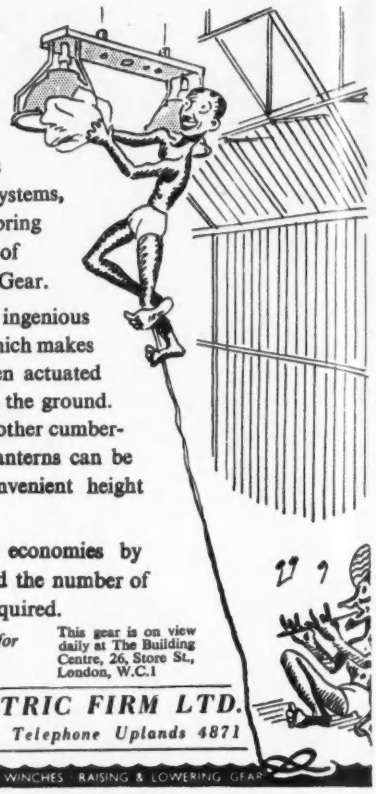

Lights that are out of reach can present a somewhat "tricky" problem when it comes to maintenance. The easiest and most convenient way to service inaccessible lights in Factories, Street Lighting systems, Aircraft Hangars, etc, is to bring them *down* to earth by means of L.E.F. Raising and Lowering Gear.

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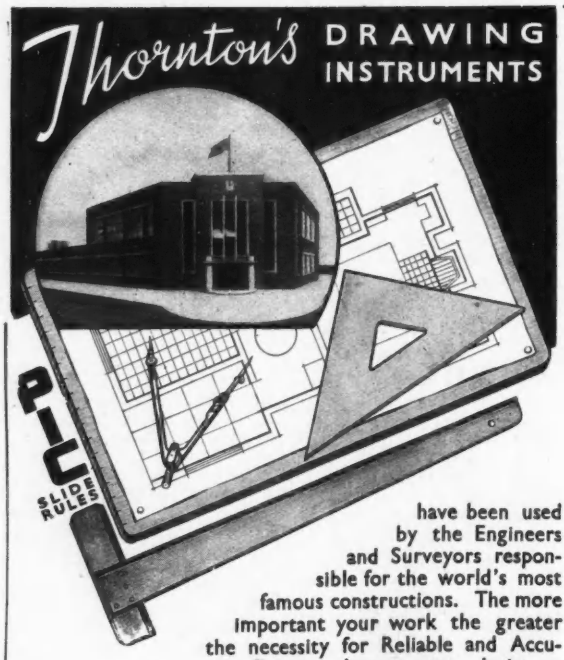

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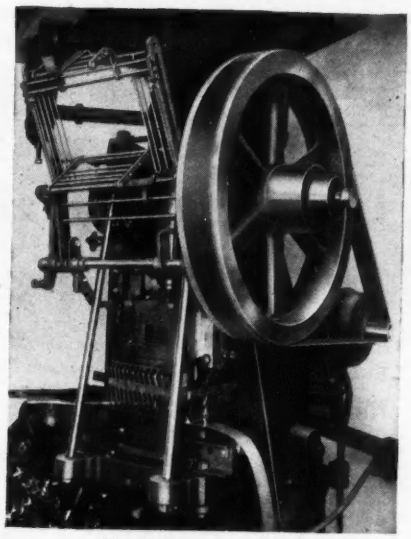

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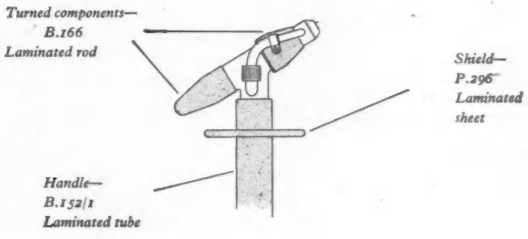

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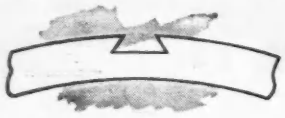
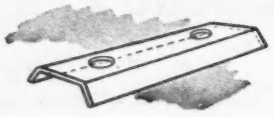
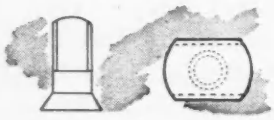


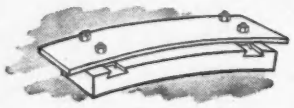
The Ferodo Lining is supplied radiused and grooved.



FEROLOK "keepers" fit firmly into the grooves. Keepers are made in sizes suitable for linings ½" thick and upwards.



FEROLOK bolts hold the keepers securely in the grooves and the dovetail action keeps the lining securely fastened to the band.



When the bolts are loosened, it simply slides into position (as shown). The nuts are then tightened and the job is done.

FEROLOK fitted linings have no rivet holes, and therefore, their working area is larger. They last longer, more safely.

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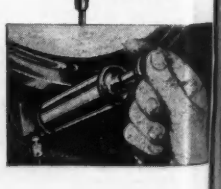

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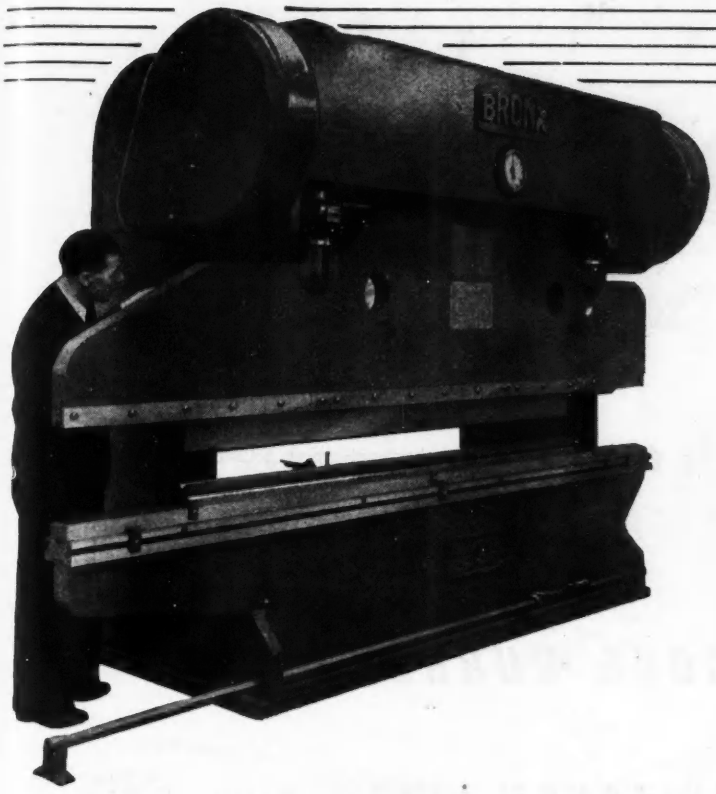

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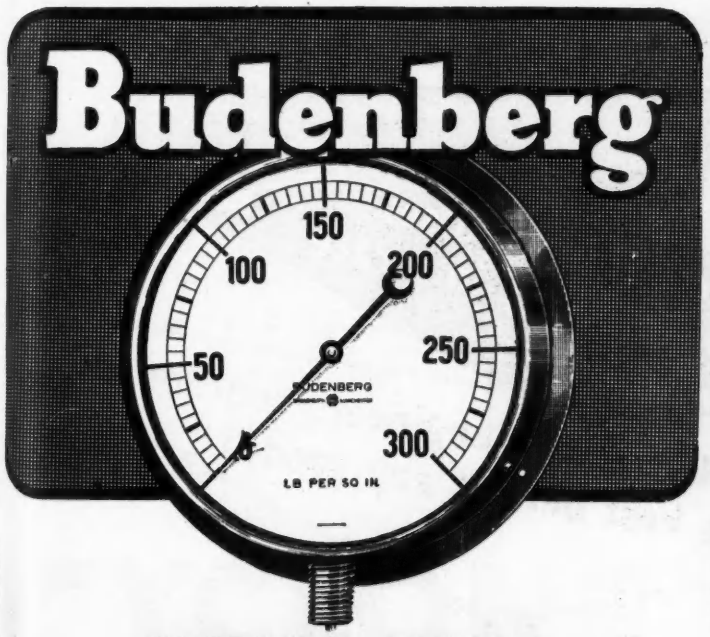

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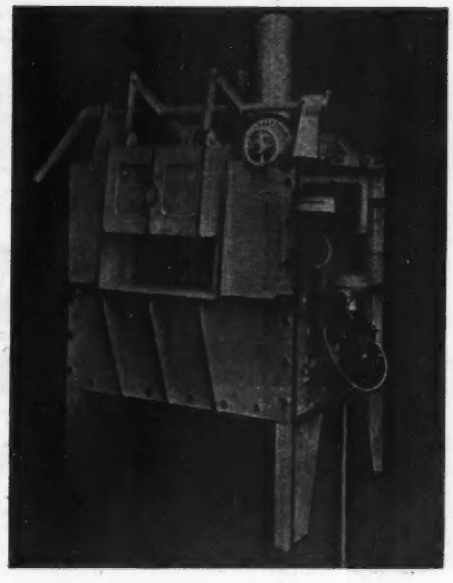

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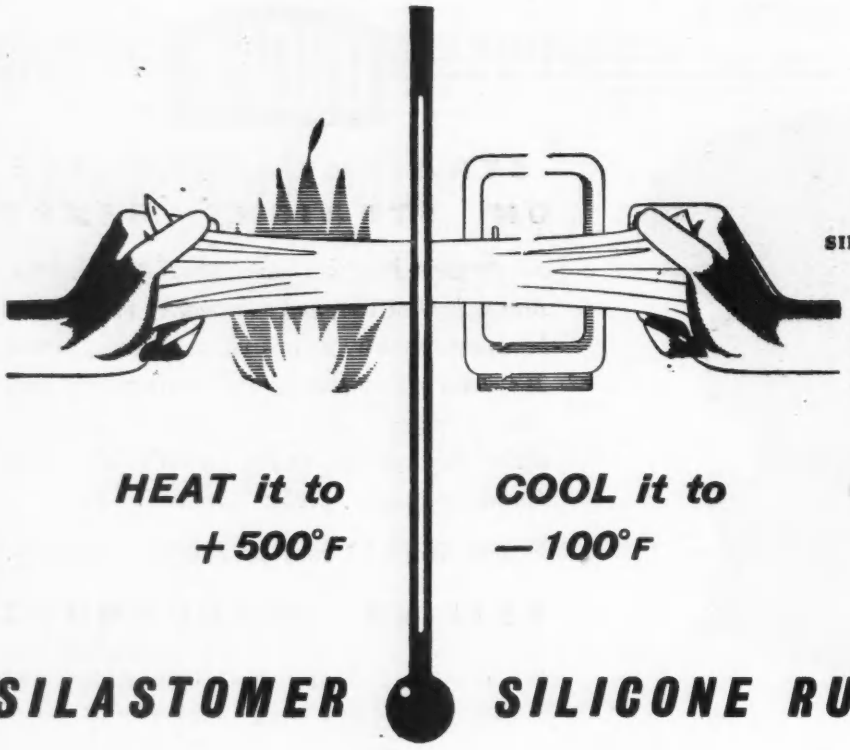

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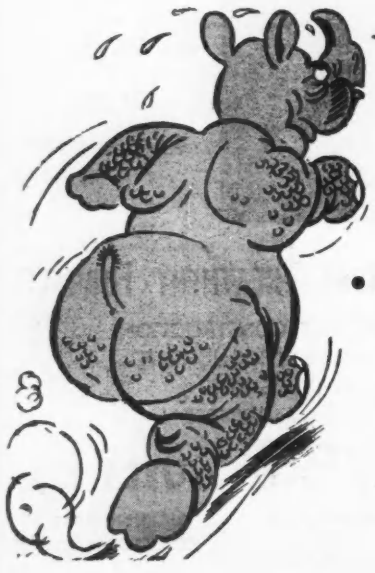

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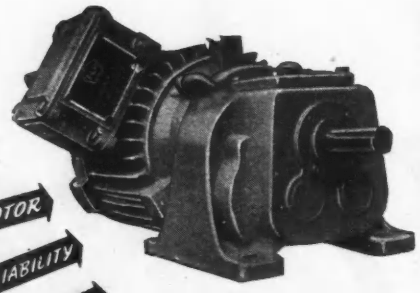

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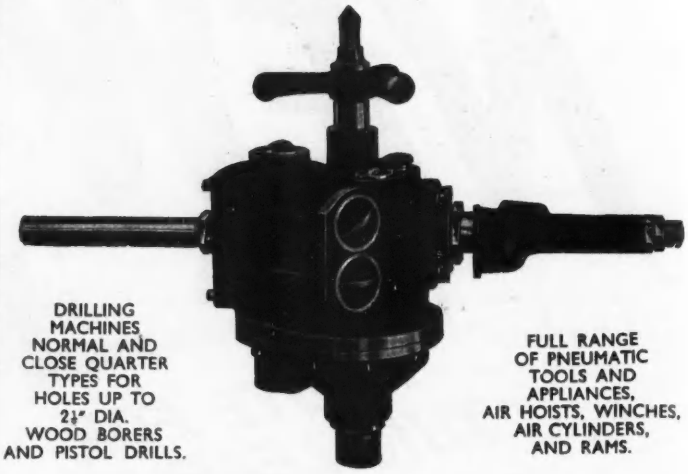

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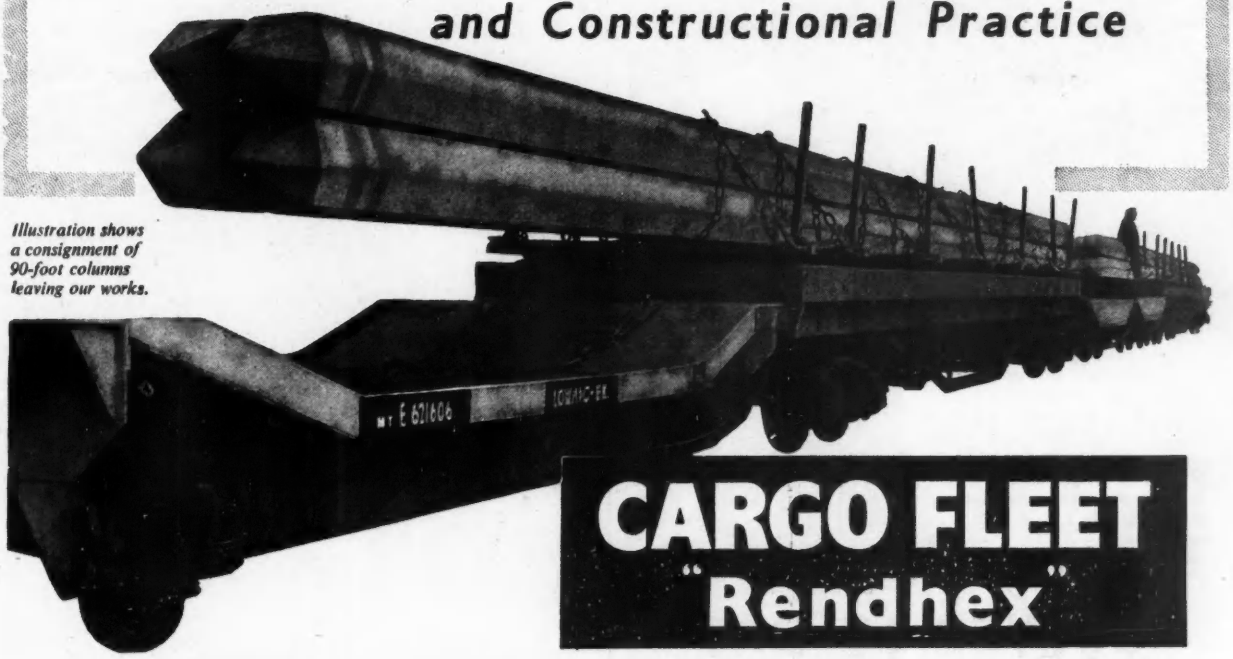

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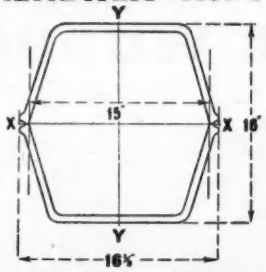
STEEL HEXAGON FOUNDATION COLUMN IN LENGTHS UP TO 120 FEET

"RENDHEX" No. 4



Weight of Rolled Section: 58.30 lbs. per ft.
Weight of Complete Column (including weld): 117.75 lbs. per ft.

About	Moment of Inertia (inches⁴)	Radius of Gyration (inches)	Section Modulus (inches³)
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YY	1,038	5.50	125.82

A lighter section
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ADVANTAGES

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EASE IN HANDLING. In relation to their strength these columns are light in weight and easily transportable.

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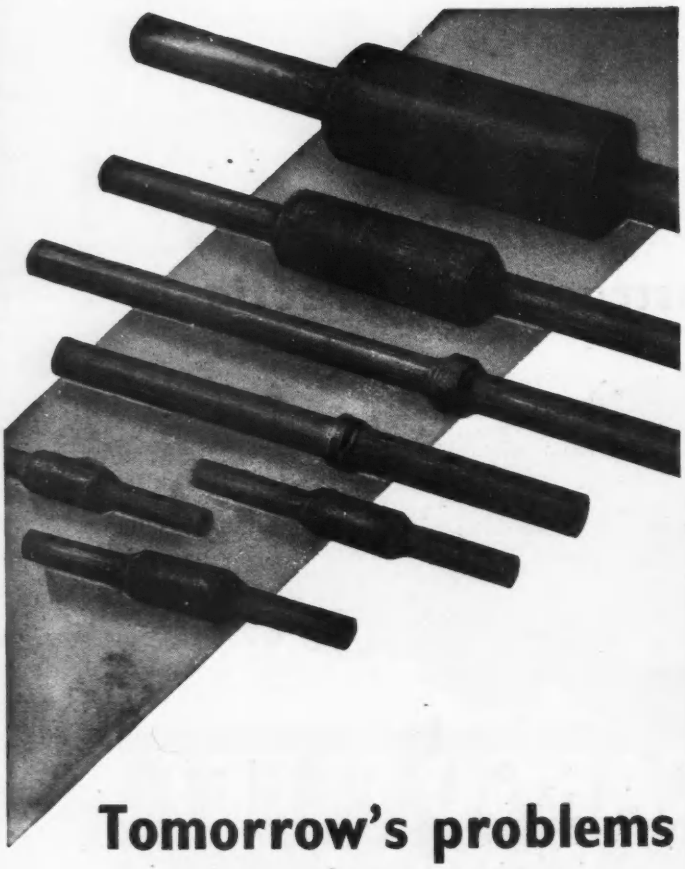

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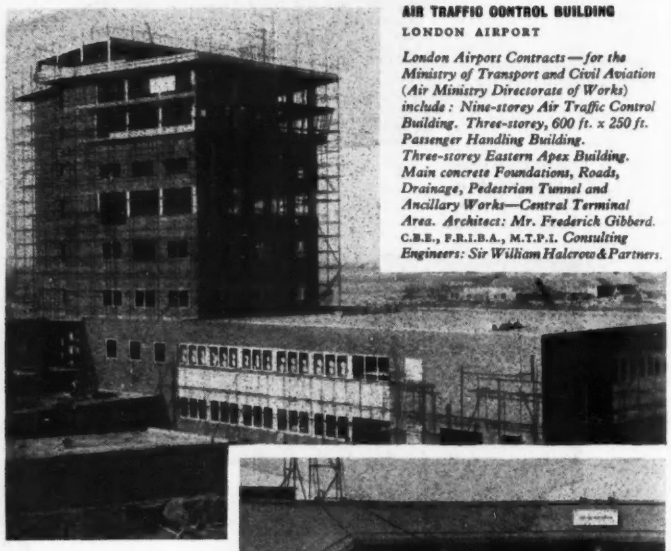

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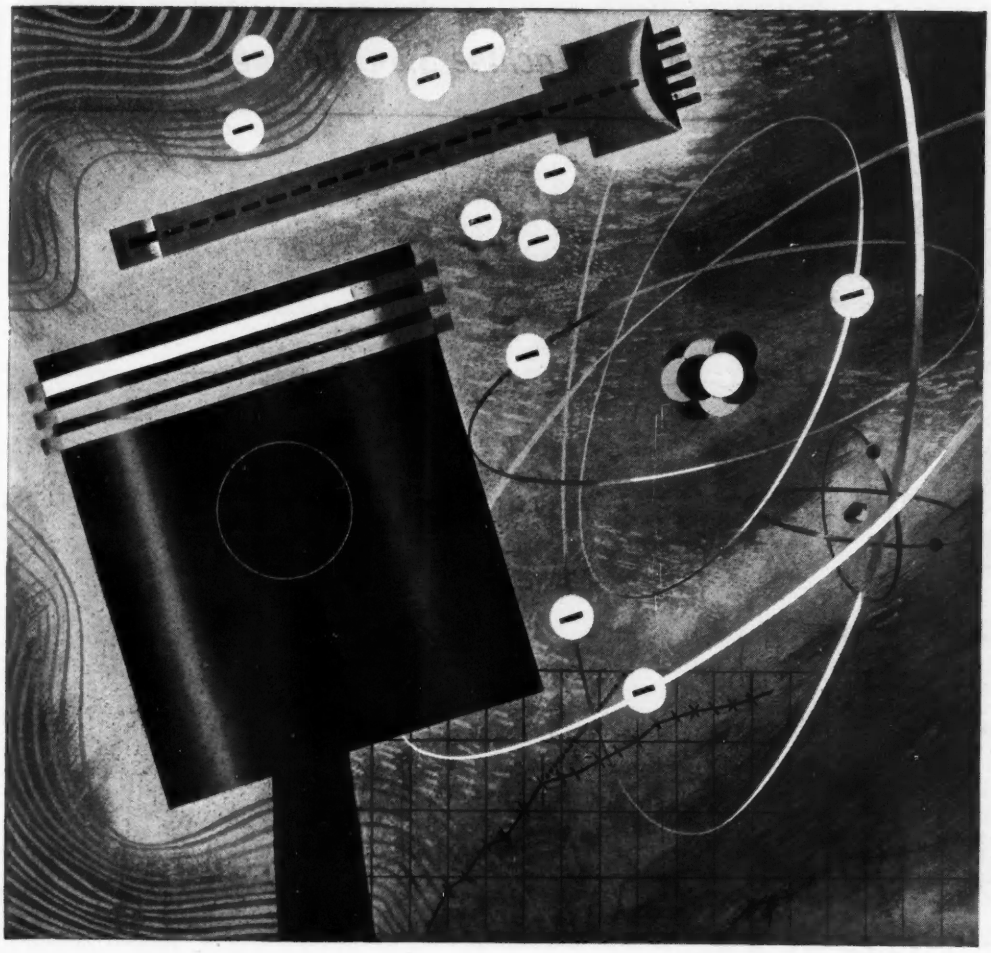

Atomic Detectives

Metal wear is no new problem, but its study at Thornton has been transformed by the use of radioactive isotopes. These are the atomic detectives of science. They record the slightest finger-print of wear.

In a test now proceeding, a radioactive piston ring fitted in an experimental engine is supplying valuable data on the *rate* of wear. Wear on the piston ring removes minute particles of radioactive metal which are carried away by the lubricating oil. As the oil returns to the sump of the engine it passes a Geiger Counter, which records the presence of radioactive metal.

In another test, a length of wire is drawn vertically through a tungsten carbide die which has been made radioactive. With the aid of radioactive tracers, which are transferred from the die to the wire, the radioactivity of the wire can be assessed by means of a Geiger Counter. By this method it is possible to measure 0.00000002 grams of die wear per foot length of wire.

These are but two examples of how work on the atom has given into the hands of Shell lubrication experts research aids that will give answers in weeks instead of years. To you that means even better performance from even better Shell lubricants. To industry it means a narrowing of the time-lag between the invention of new machines and the development of lubricants to suit them.

Shell's laboratories at Thornton, Cheshire, cover an area of 800,000 sq. ft. and are manned by a staff of over 800—that's how Shell makes sure.

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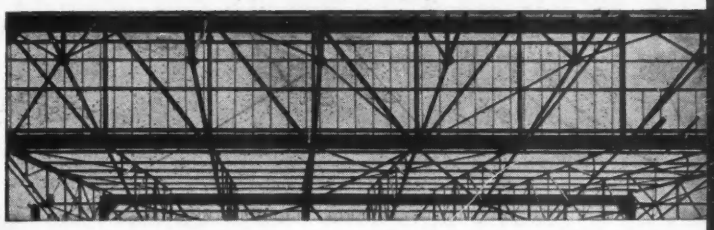
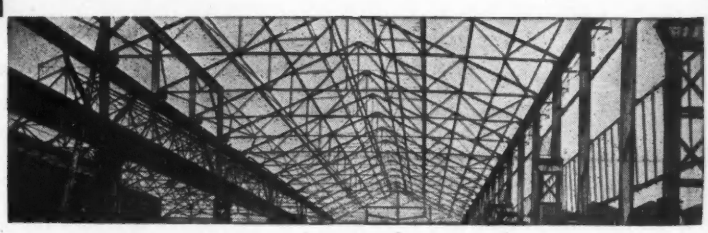


designed, fabricated and erected



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Horace and the Machine Shop Foreman **No.1**

The Machine Shop Foreman wriggled his toes in the sand and tried to ignore the voice that piped in his left ear. 'But suppose,' persisted Horace, 'the tide didn't come back—would this be called a sand-side town?' Wearily the M.S.F. raised himself on his elbow. 'The tide, Horace,' he explained, 'is one of those infallible things . . . you can always rely on it . . . it never varies . . . it never lets you down!' Horace's frown cleared. 'Oh,' he breathed in wonder, 'like that Tecalemit Automatic Lubrication you're always talking about!' 'That's right,' said the M.S.F., and covering his face with a newspaper he slumbered.

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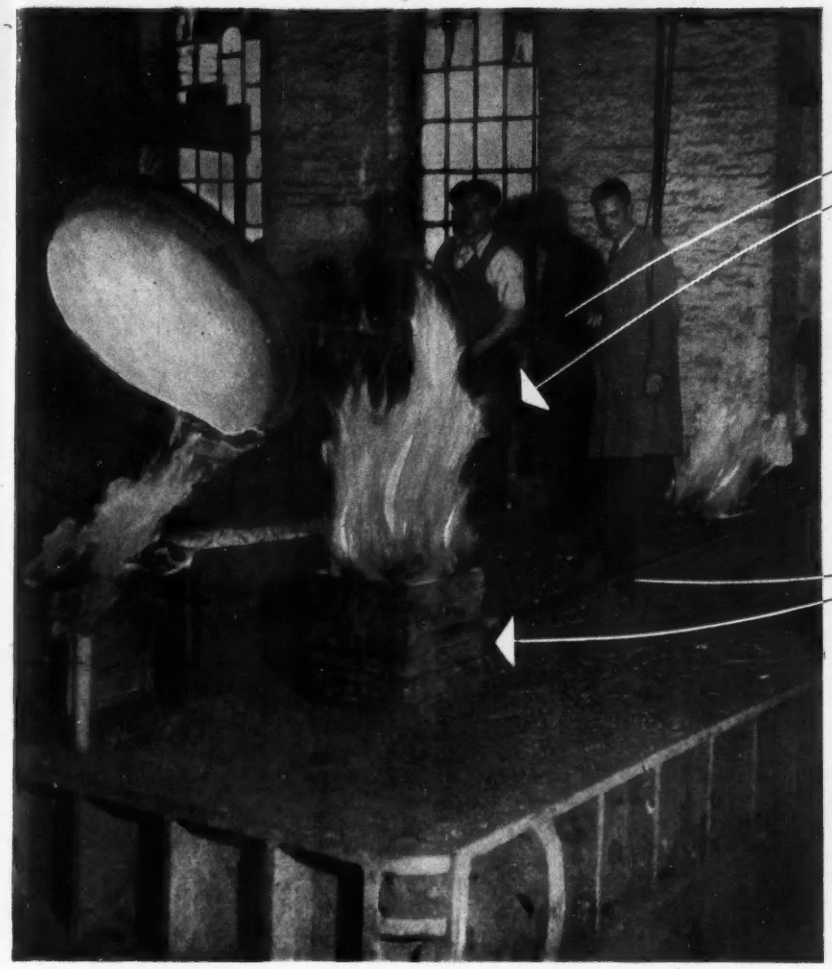

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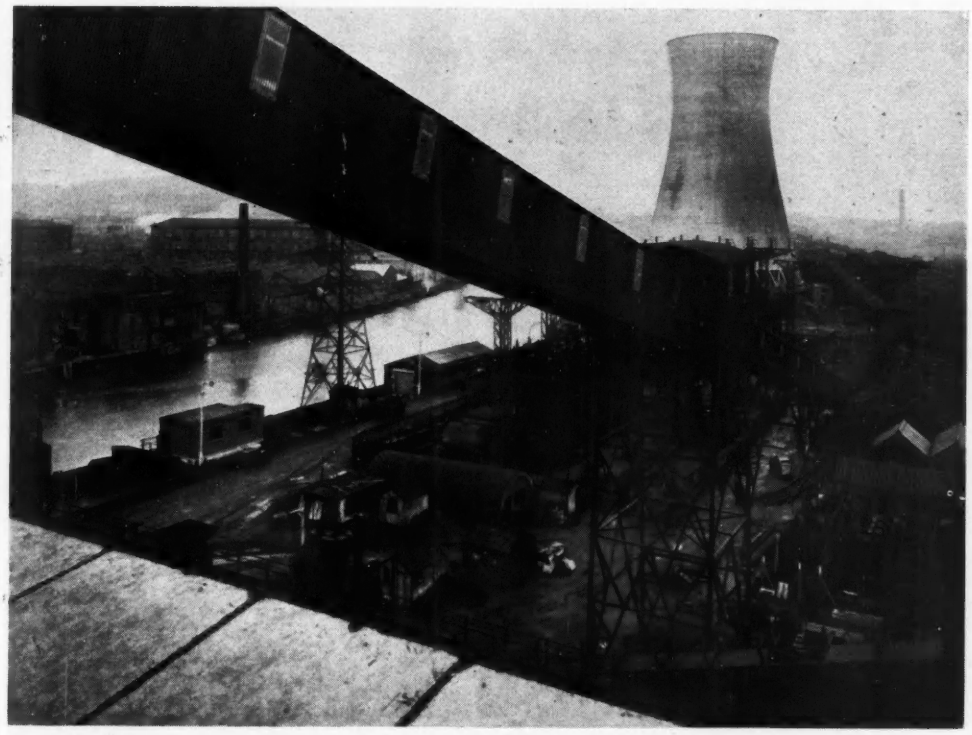

At a Yorkshire Power Station of the British Electricity Authority seven 36" wide conveyors totalling 585 yards in length handle coal from a canal wharf to the boiler house bunkers at the rate of 200 tons per hour.

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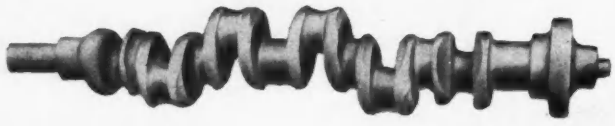

In the manufacture of engines for heavy road transport vehicles MASSEY Forging Plant is used for the production of high precision forgings. The photograph shows a large MASSEY Bridge Type Drop Hammer producing engine crankshaft forgings at Messrs. Smith-Clayton Forge Ltd., Lincoln. These MASSEY Drop Hammers are made in a range of sizes from 10 cwt. to 16 tons capacity, and produce forgings of the most intricate type at high production speeds. Their ease of control and adaptability, added to considerable economy in running and upkeep costs, make them essential in any general forge.

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Photographs by courtesy of Messrs. Smith-Clayton Forge Ltd. Lincoln.

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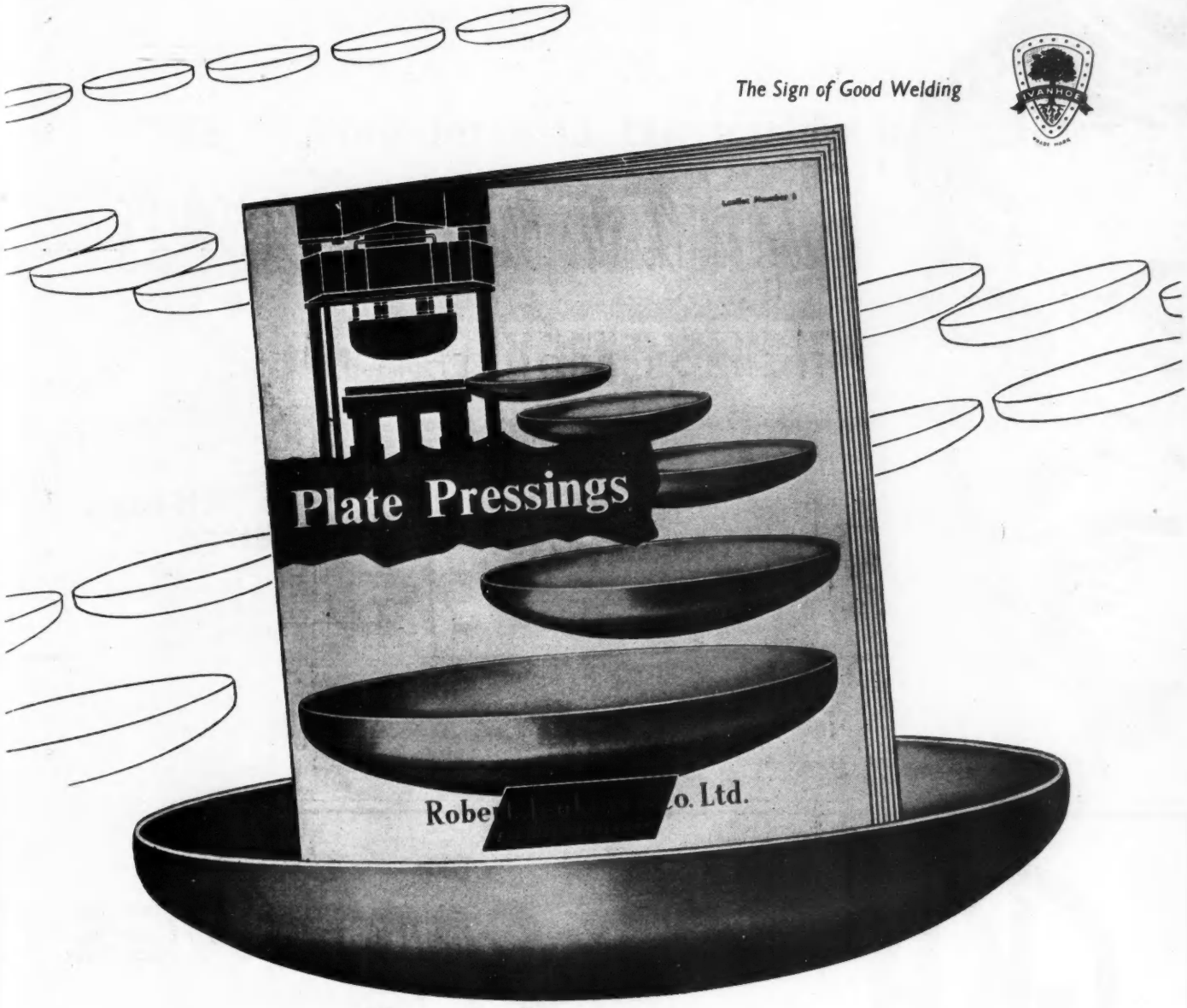

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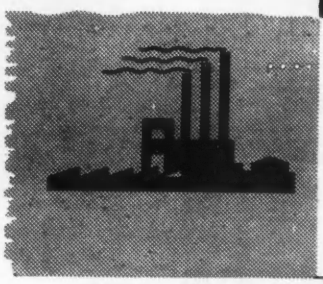

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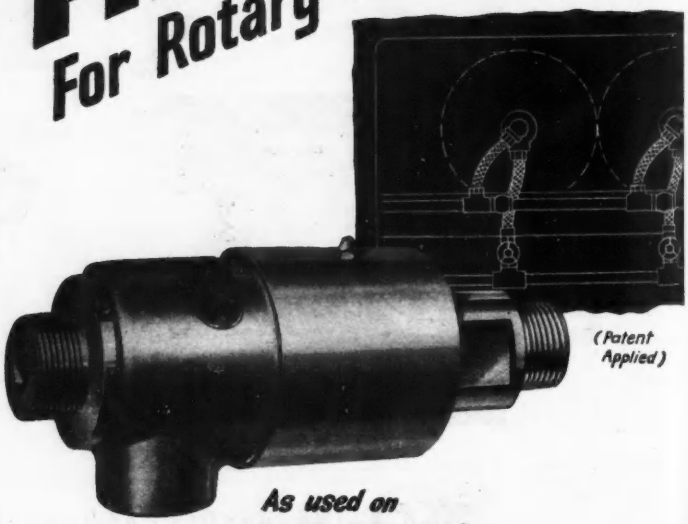

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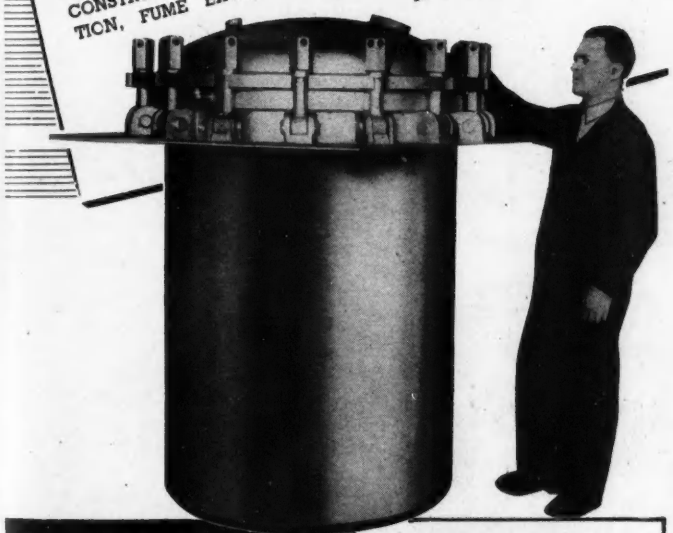

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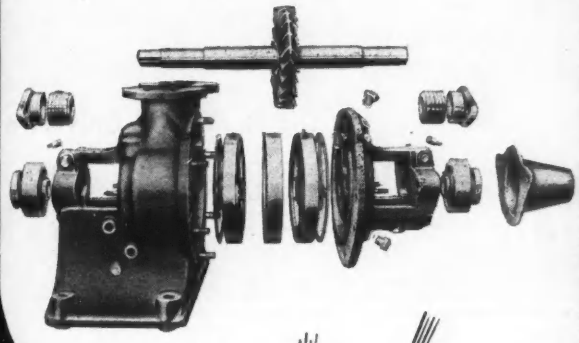

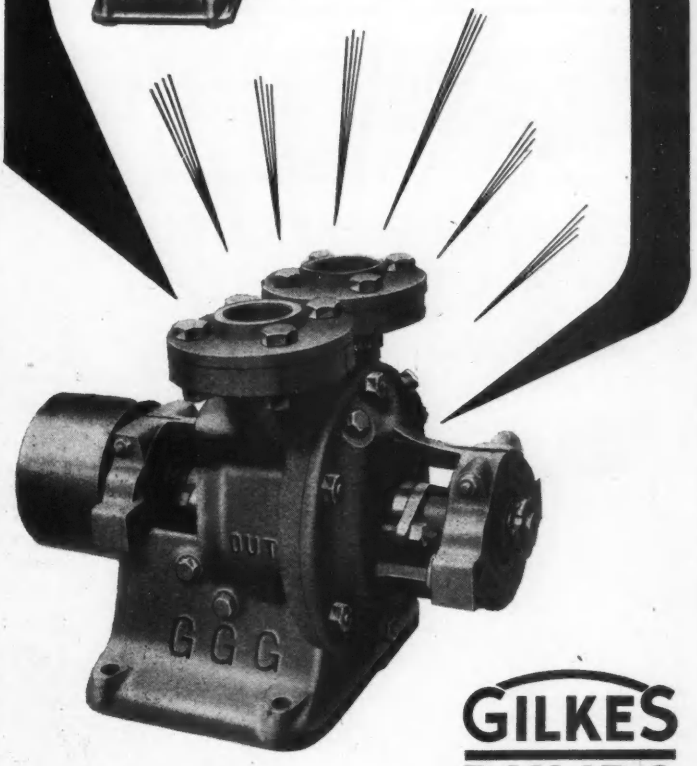

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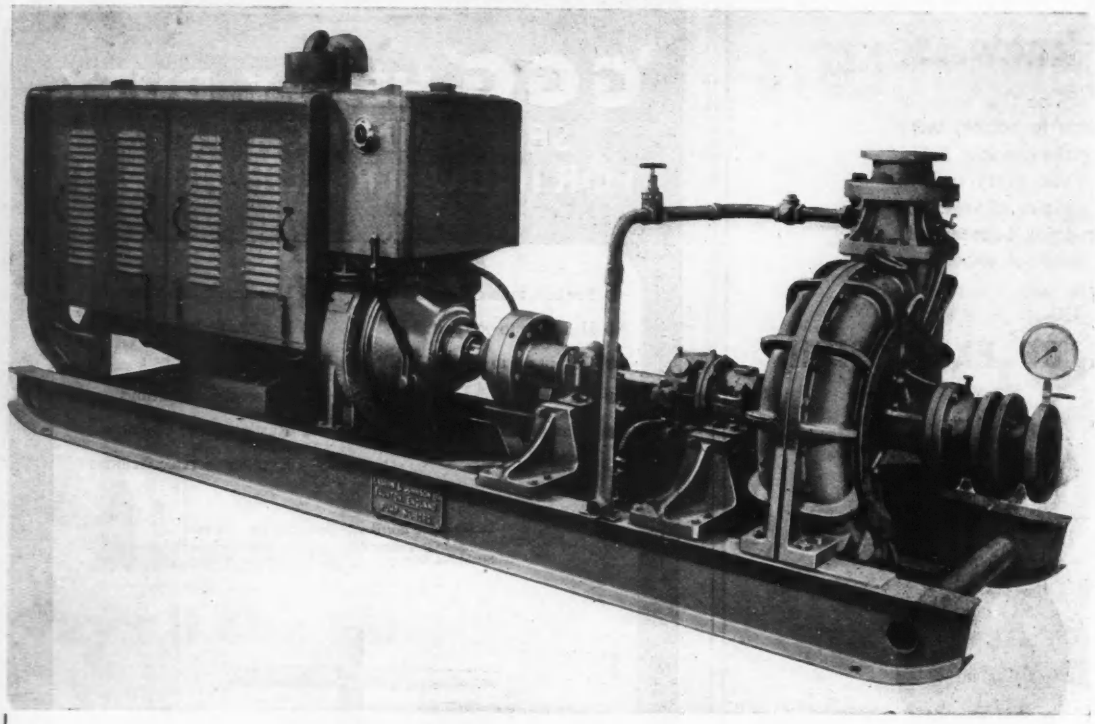

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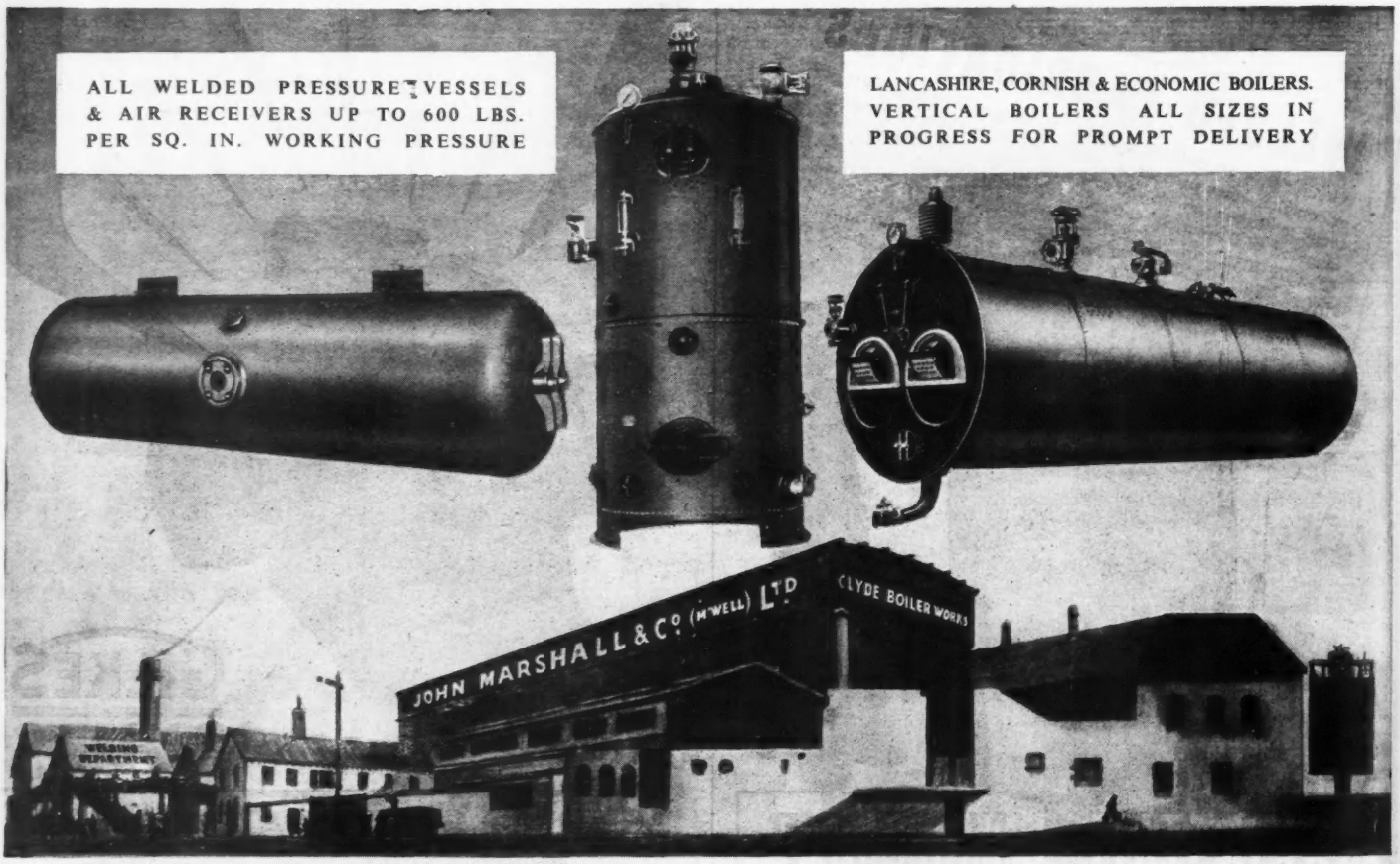

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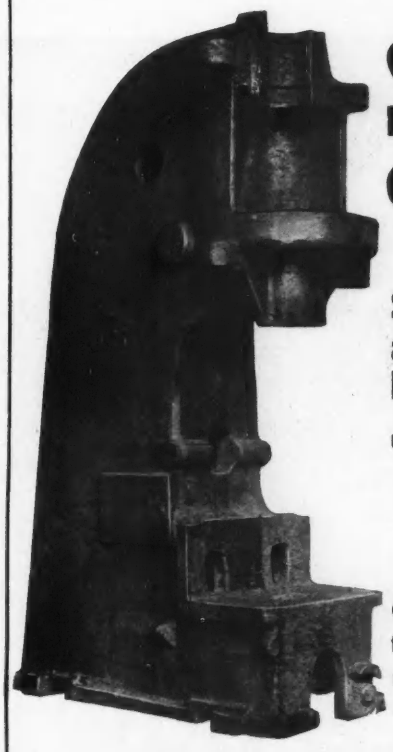

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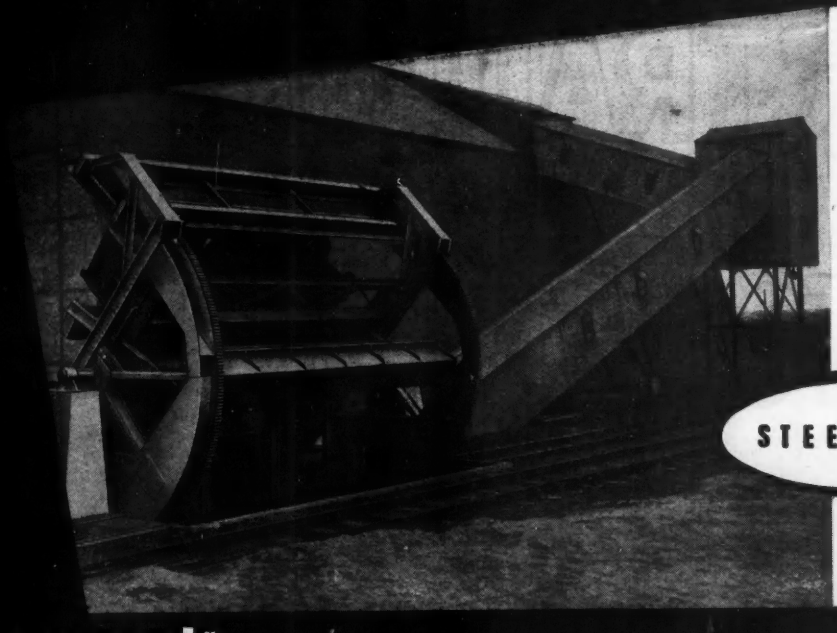

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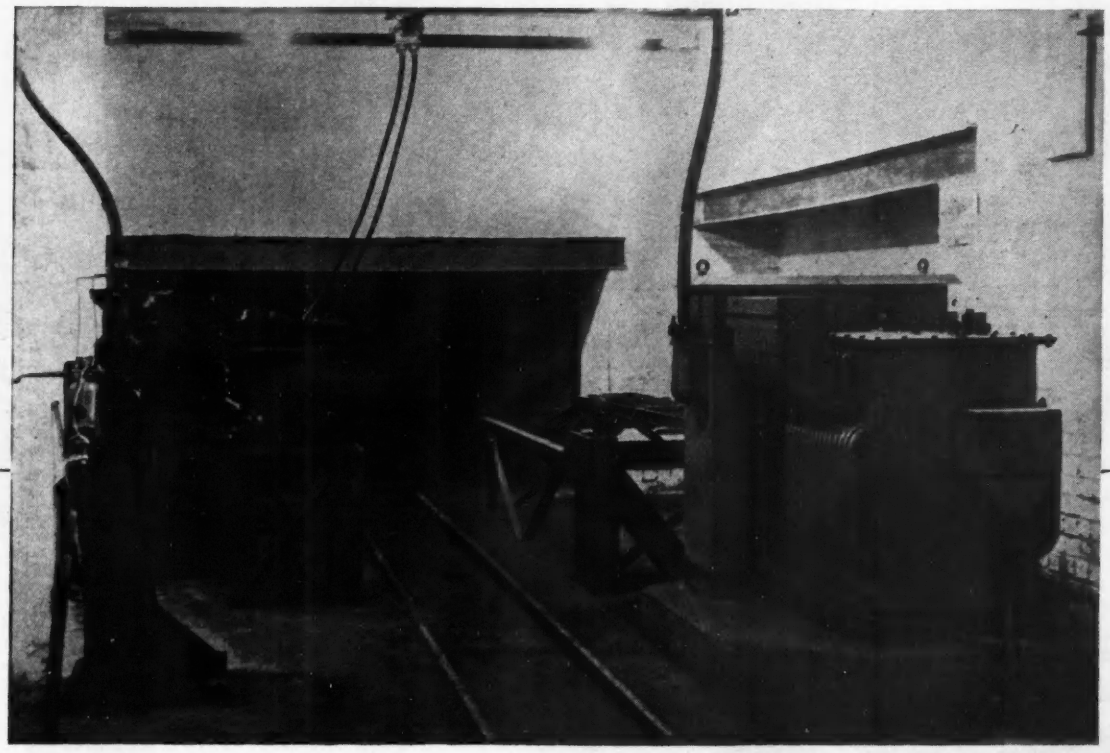

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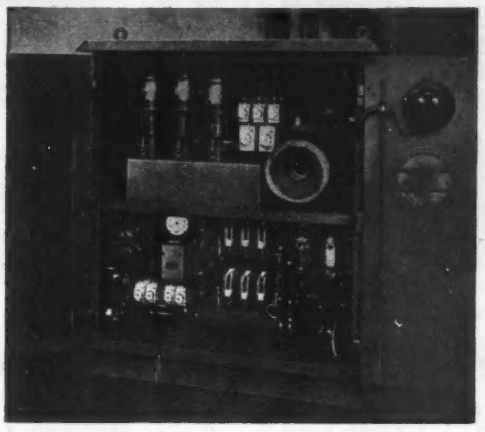

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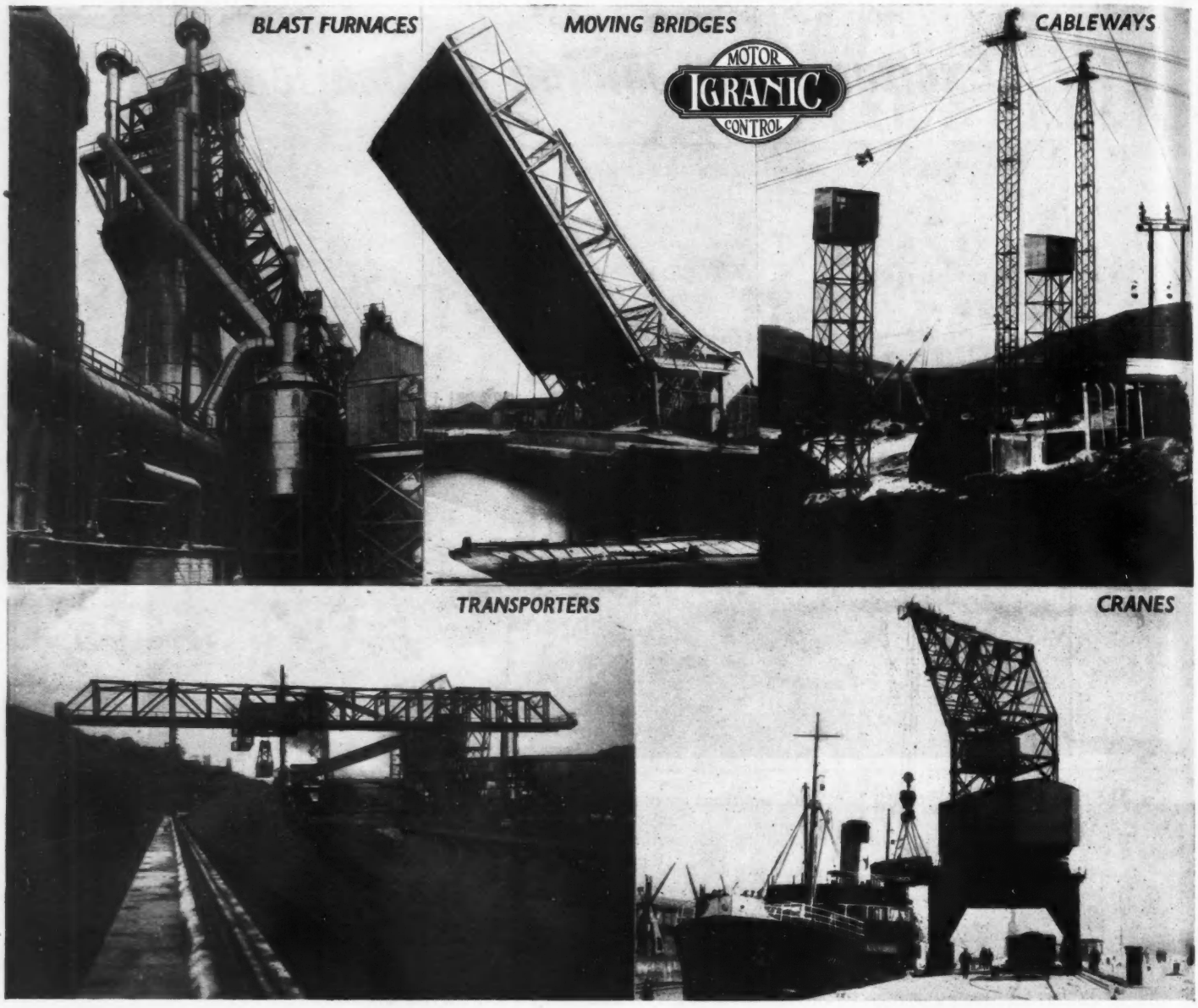

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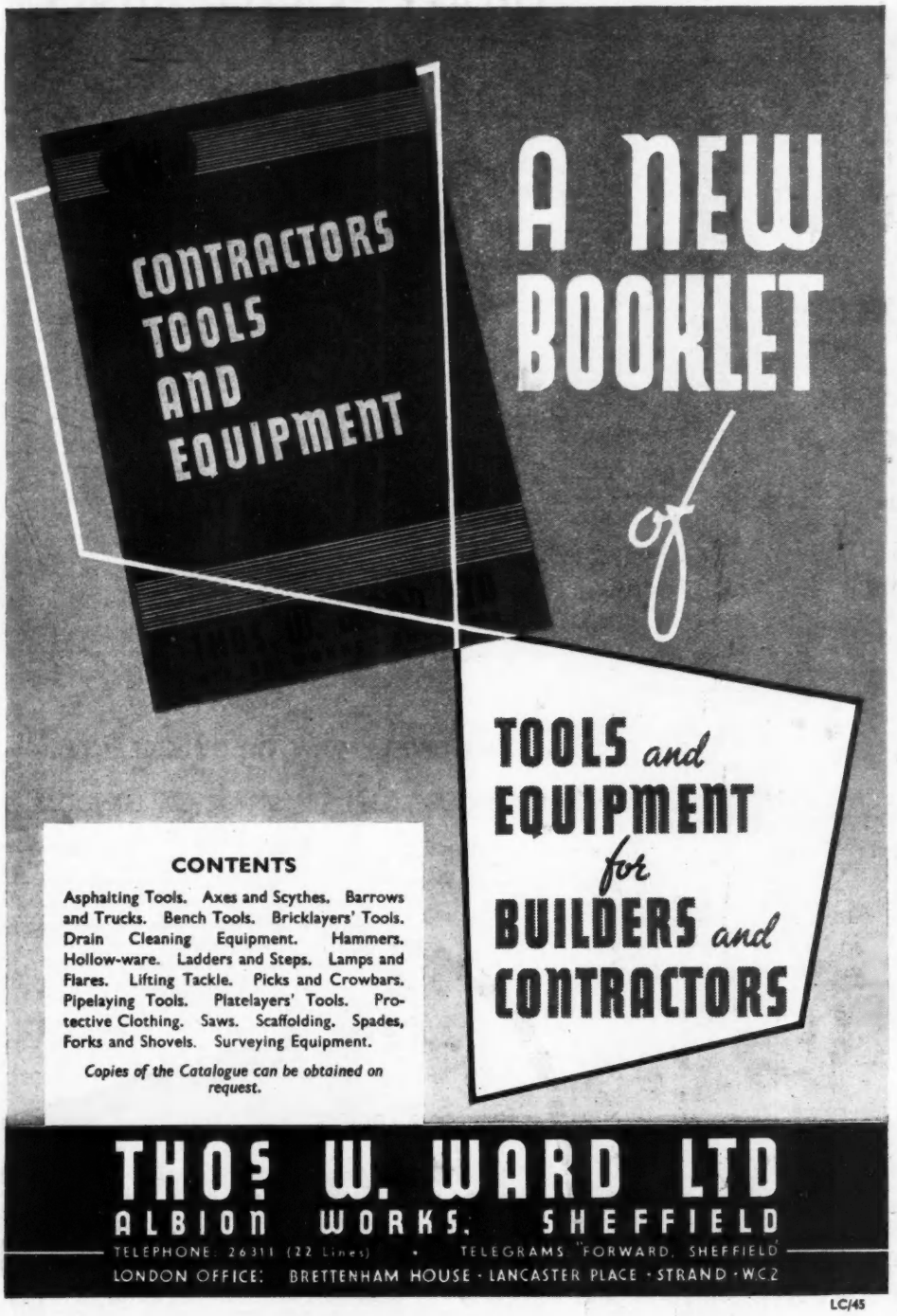

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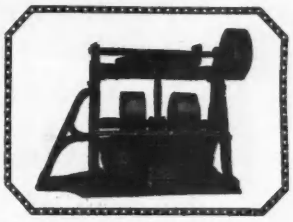

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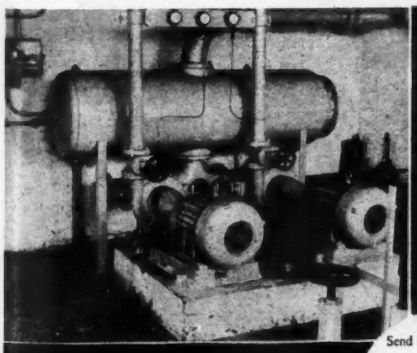

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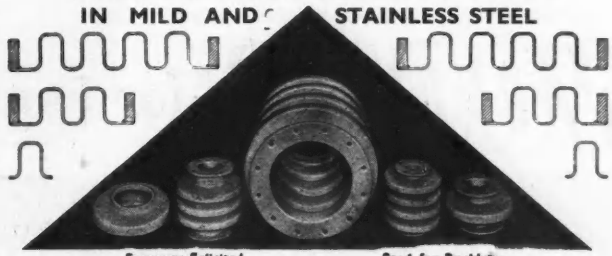

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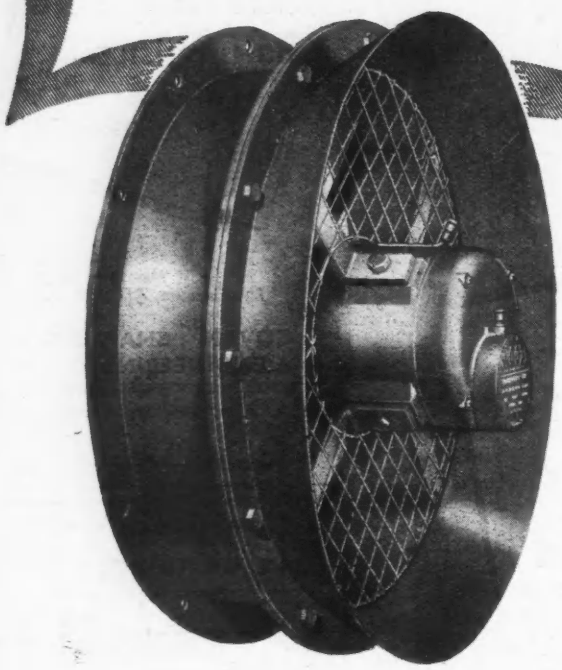

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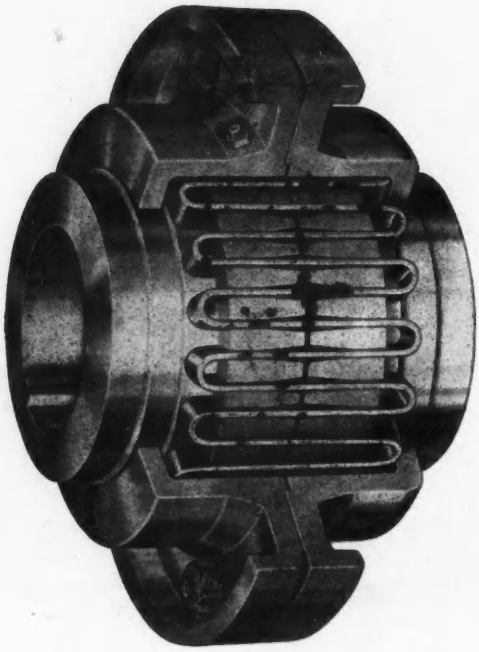

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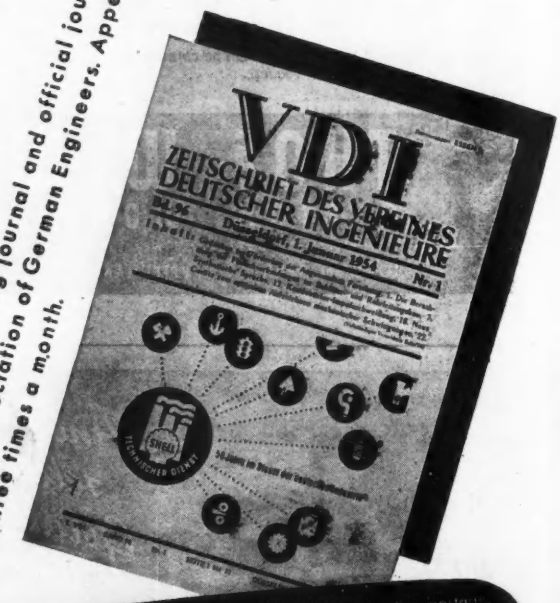

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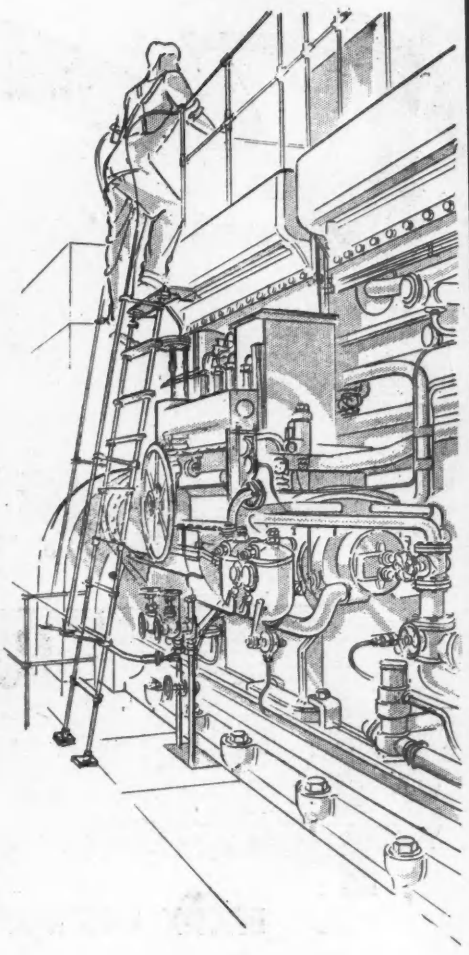

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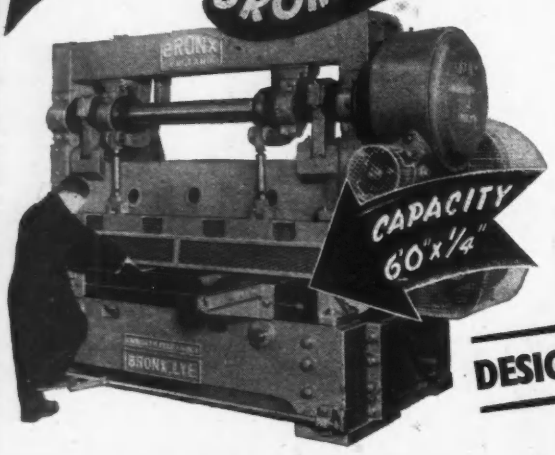

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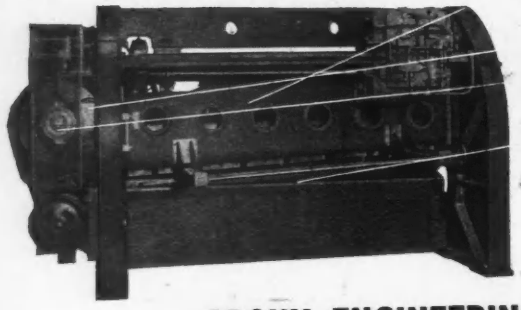

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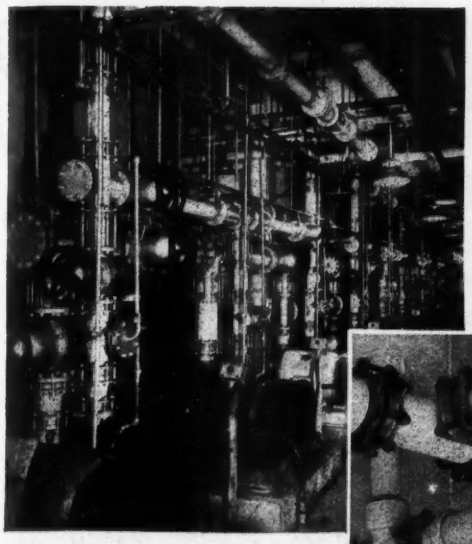

Royal Doulton Stoneware Pipe-Lines at the catalyst plant of Joseph Crosfield & Sons Ltd., at Warrington, and (inset) close-up of fixed-flange joints.

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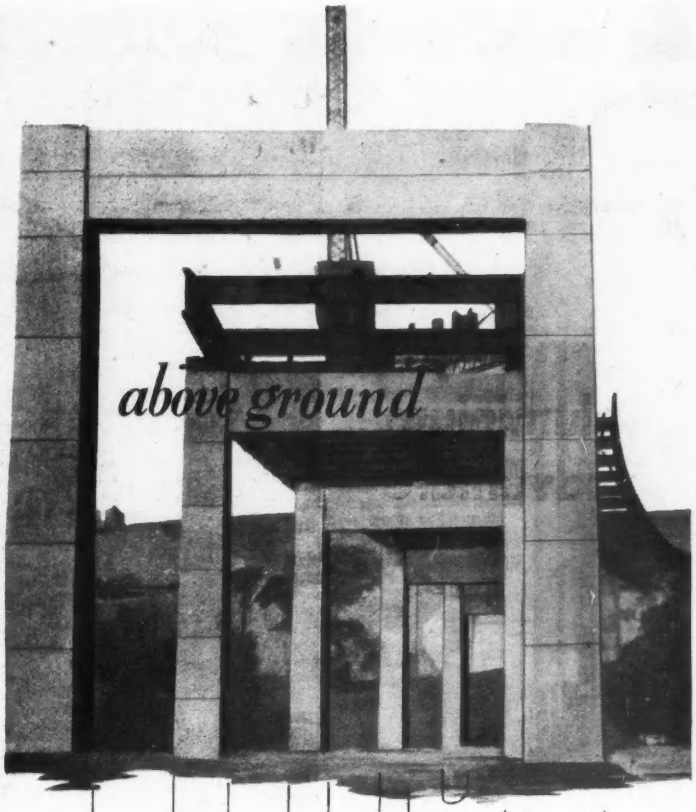

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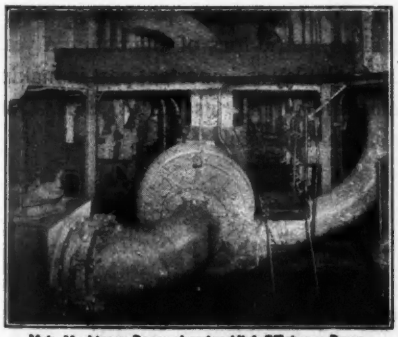

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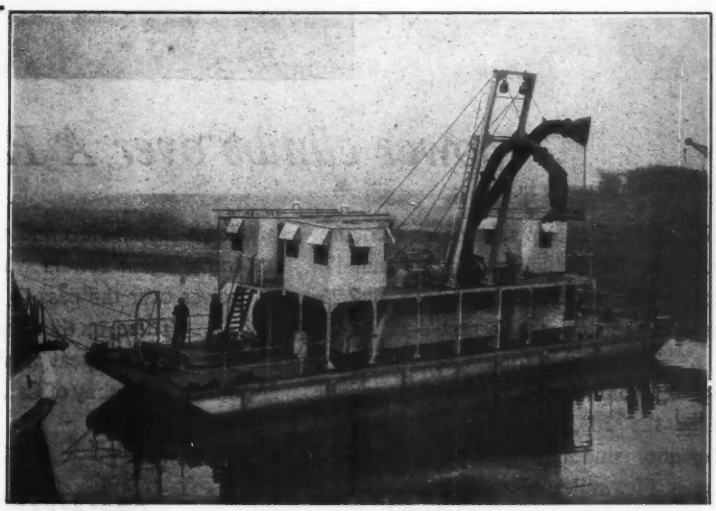

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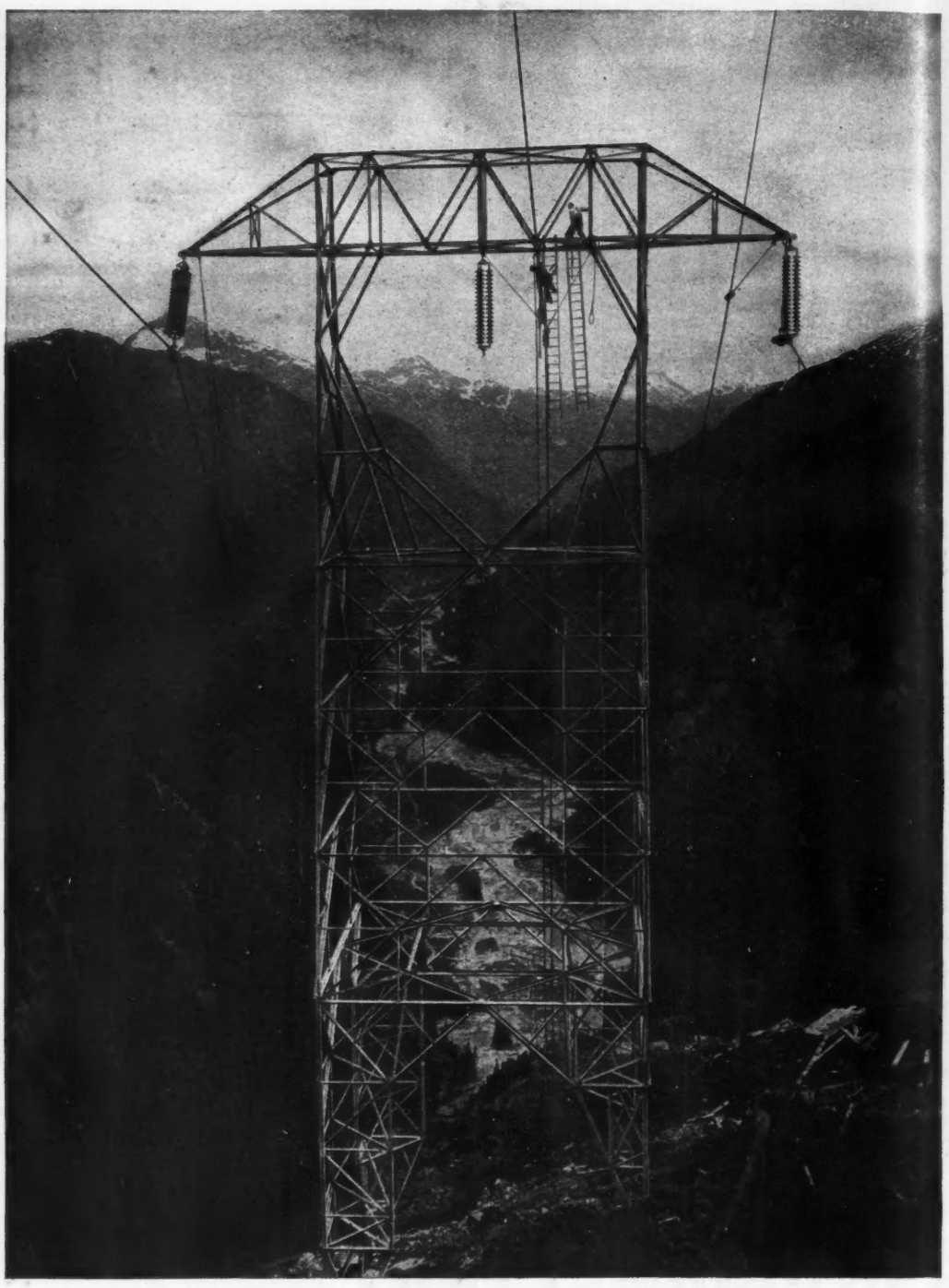

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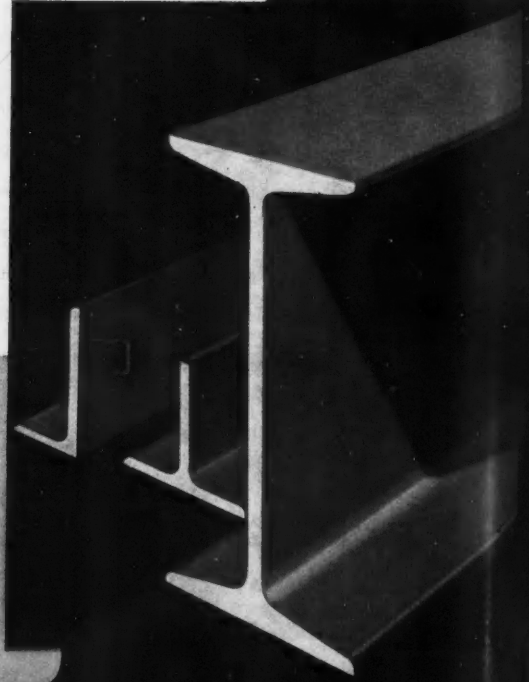

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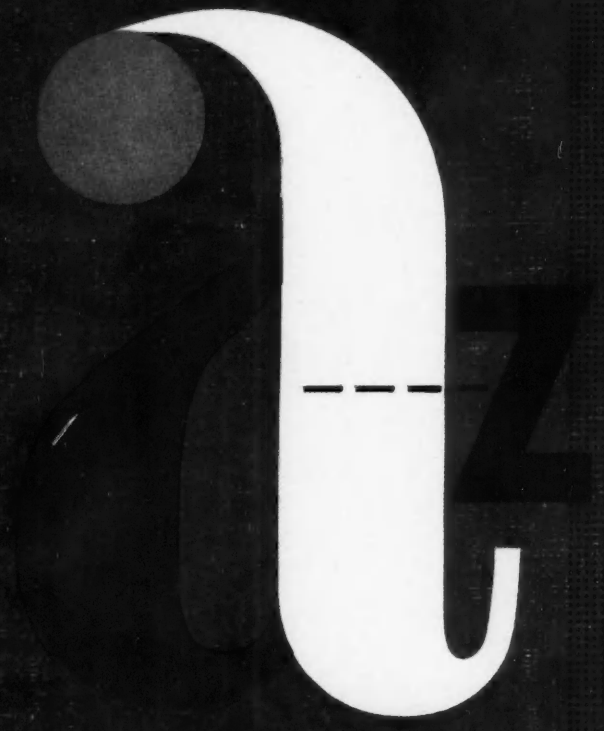

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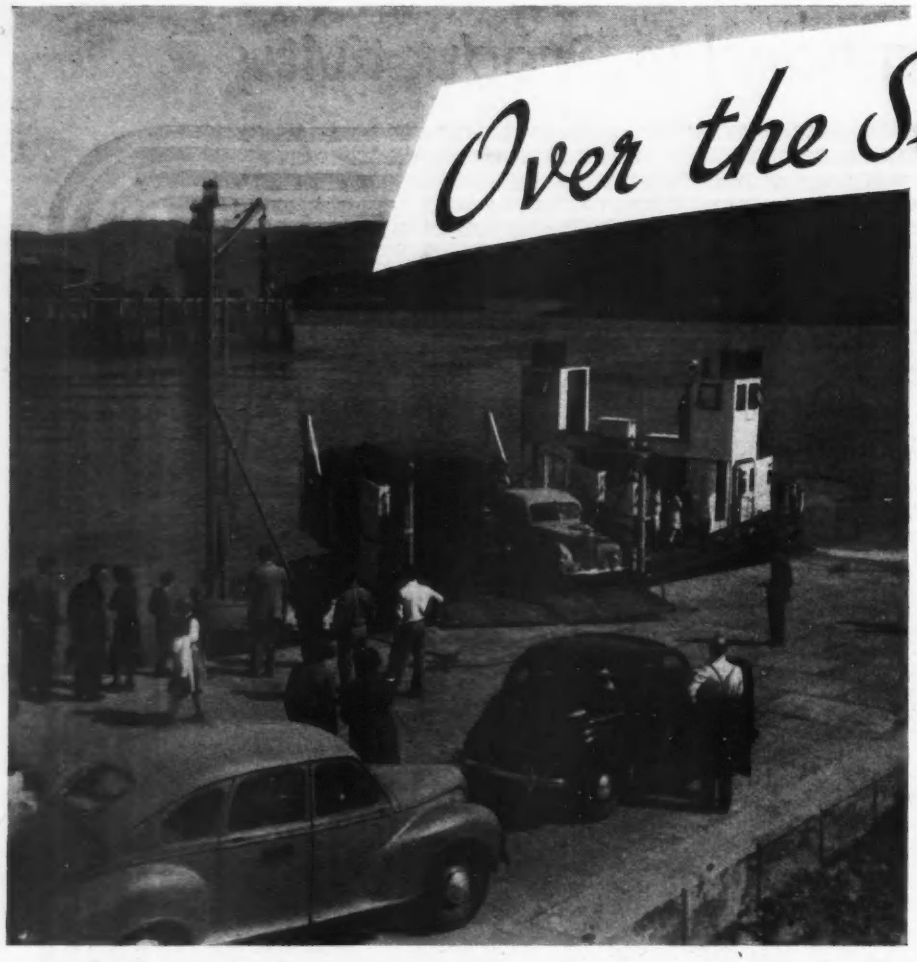

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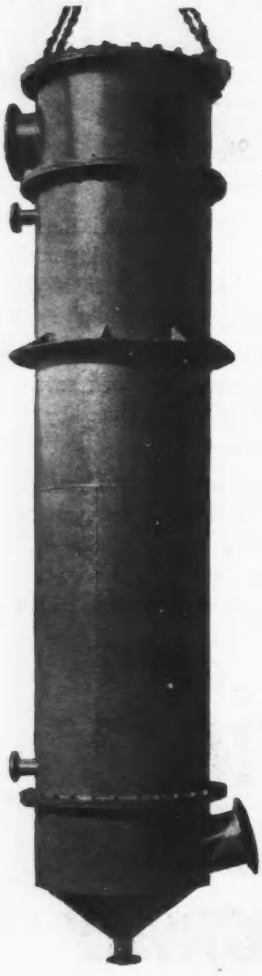

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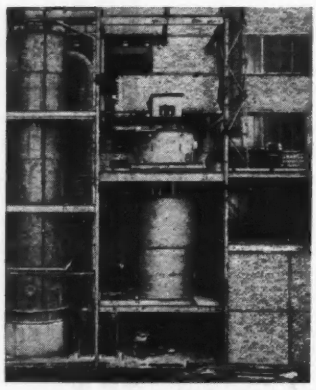

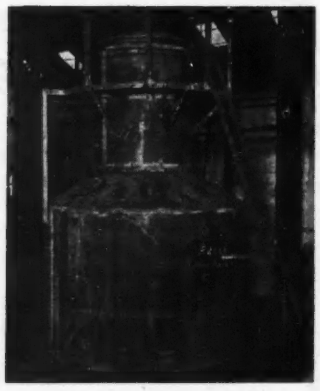

Left: Vertical Tubular Condenser with top and bottom chambers, 17′ 6″ overall length, 3′ 6″ diameter.
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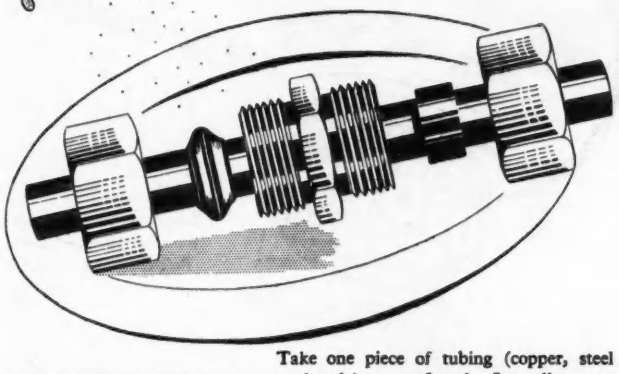

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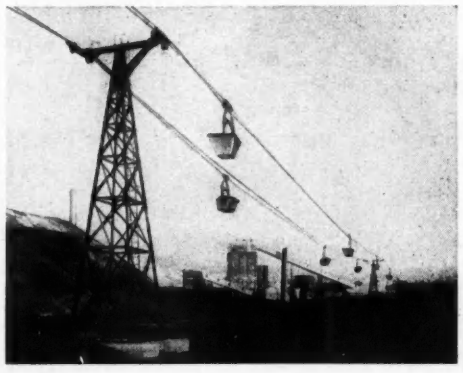

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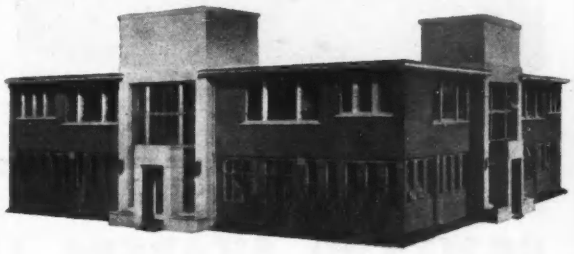

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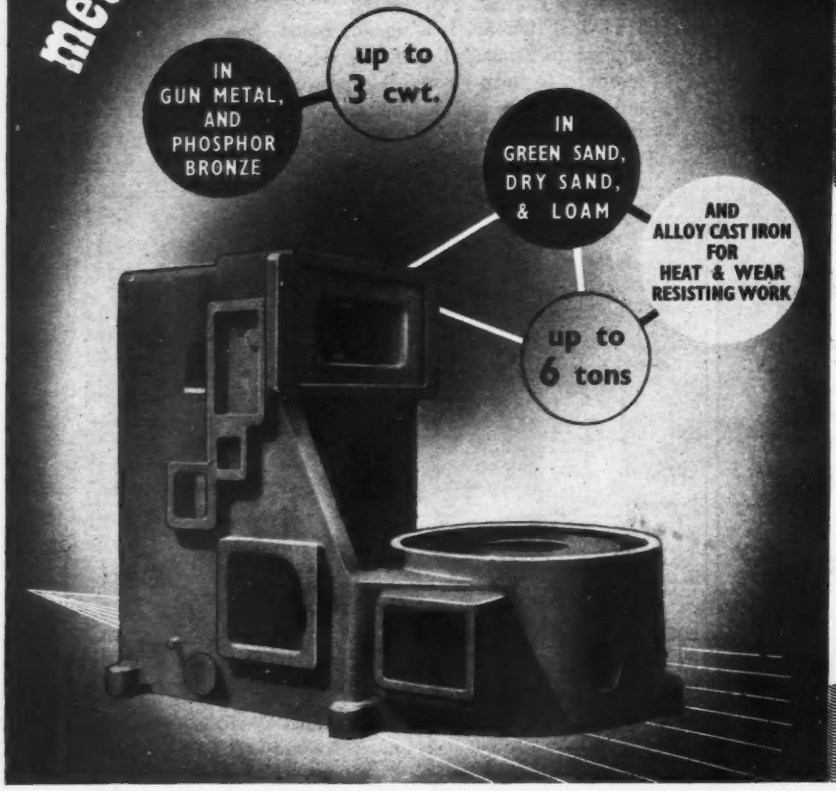
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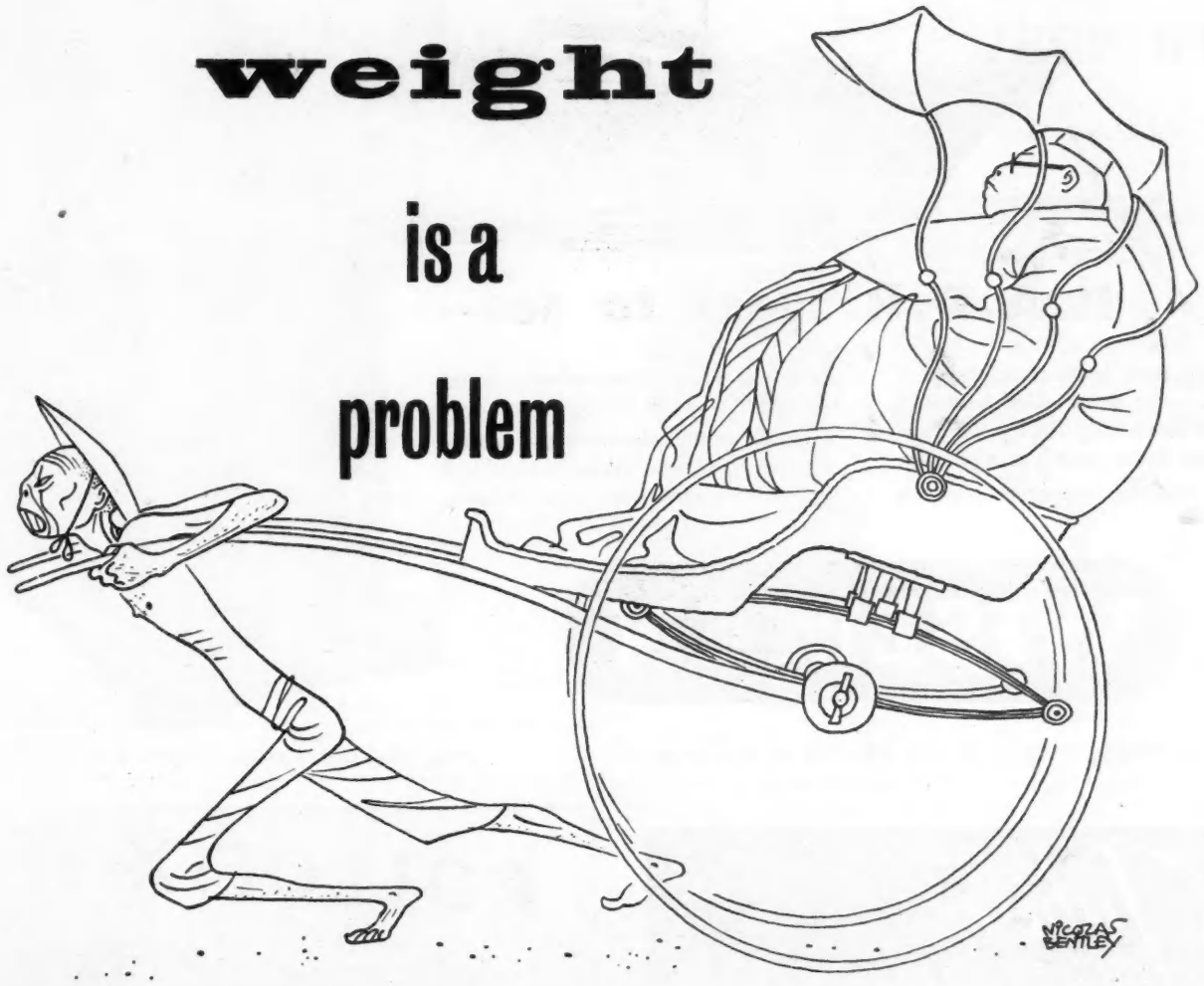

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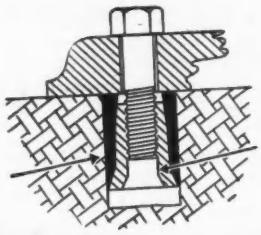

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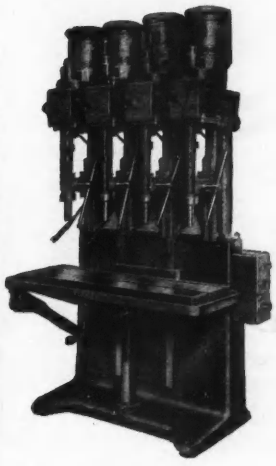

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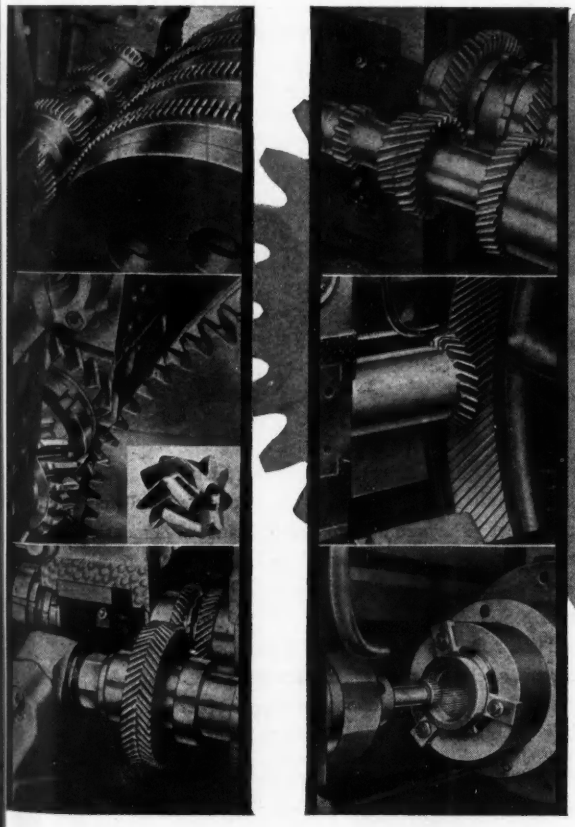

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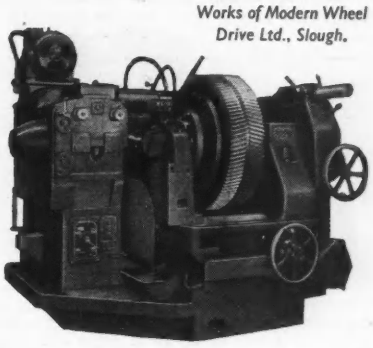

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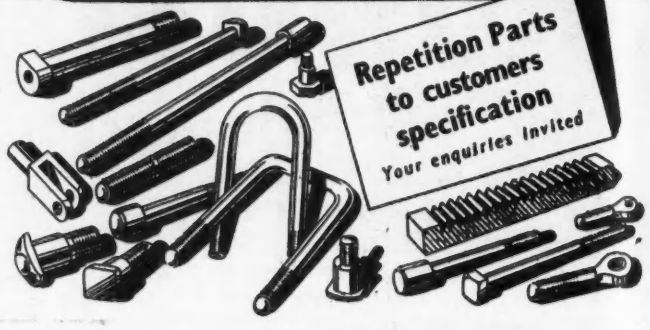

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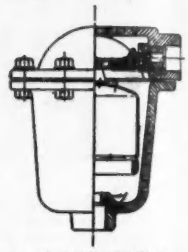

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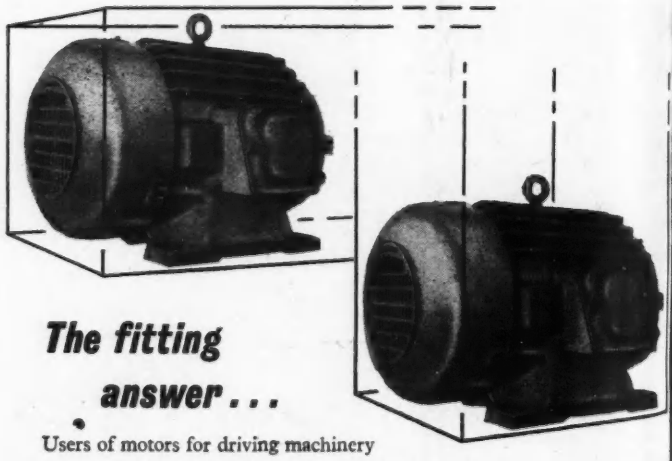

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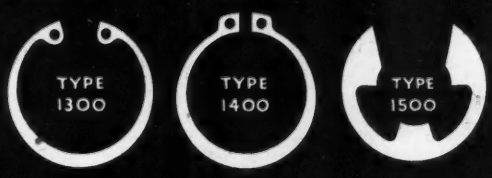

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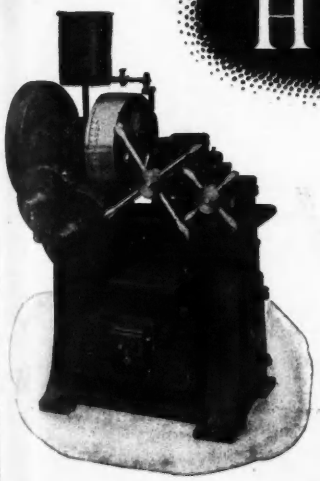

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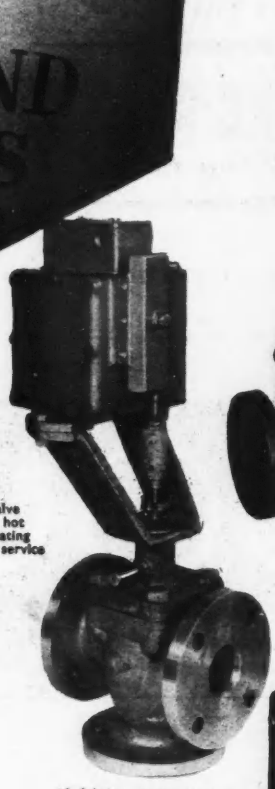

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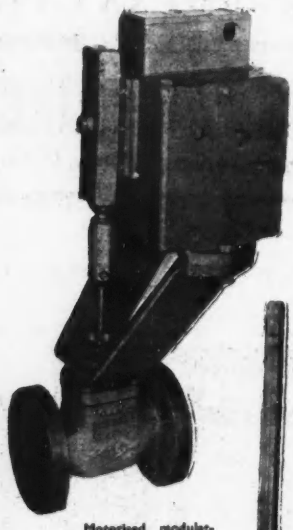

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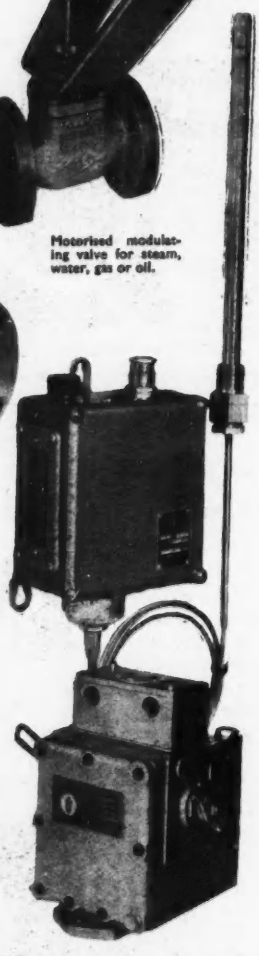

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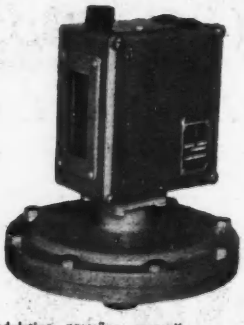

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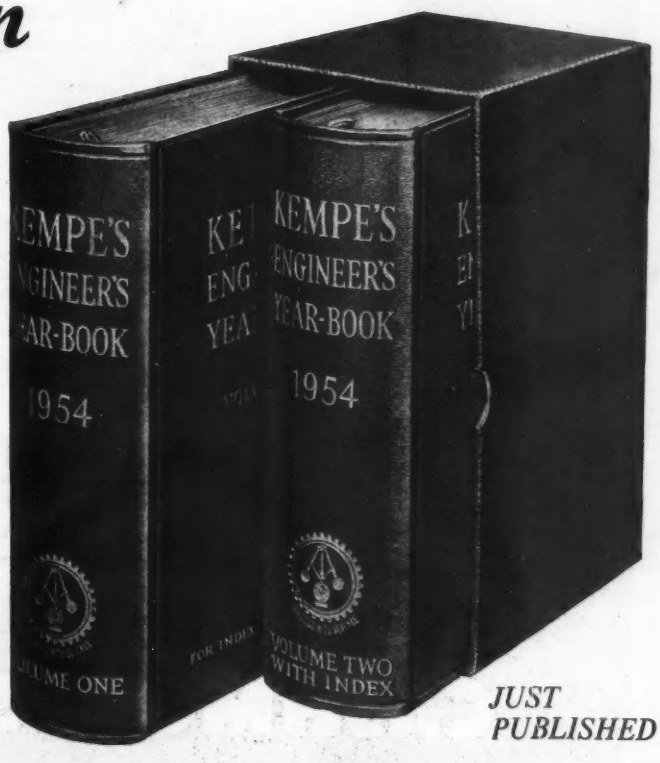

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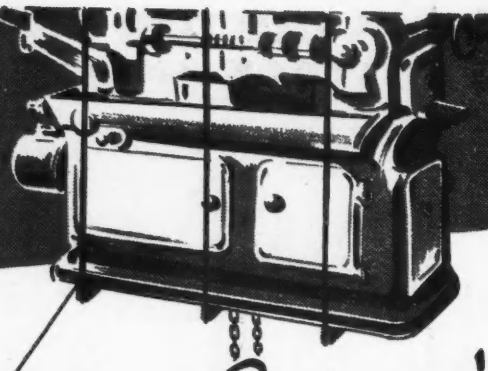

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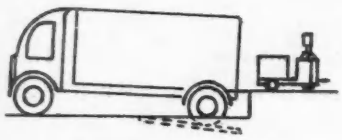
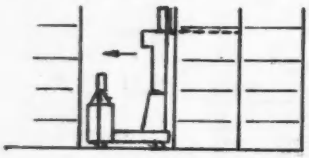
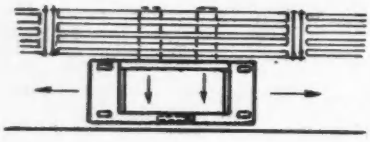
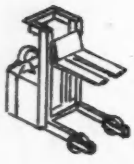
*** 

*** 

*** 

** 

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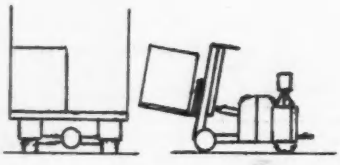
* 

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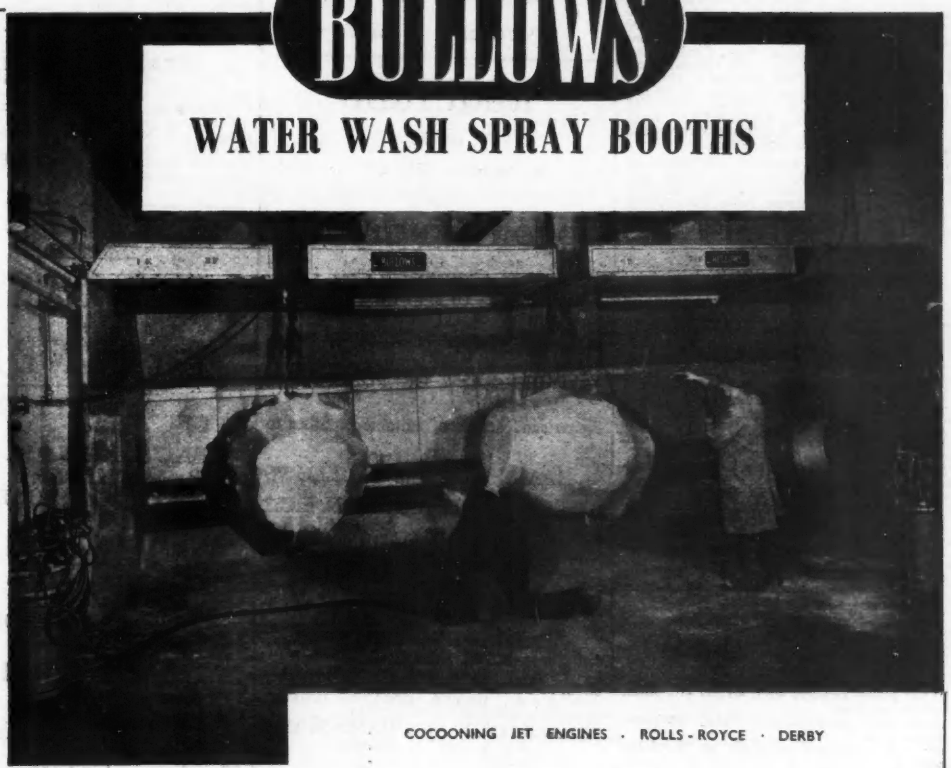

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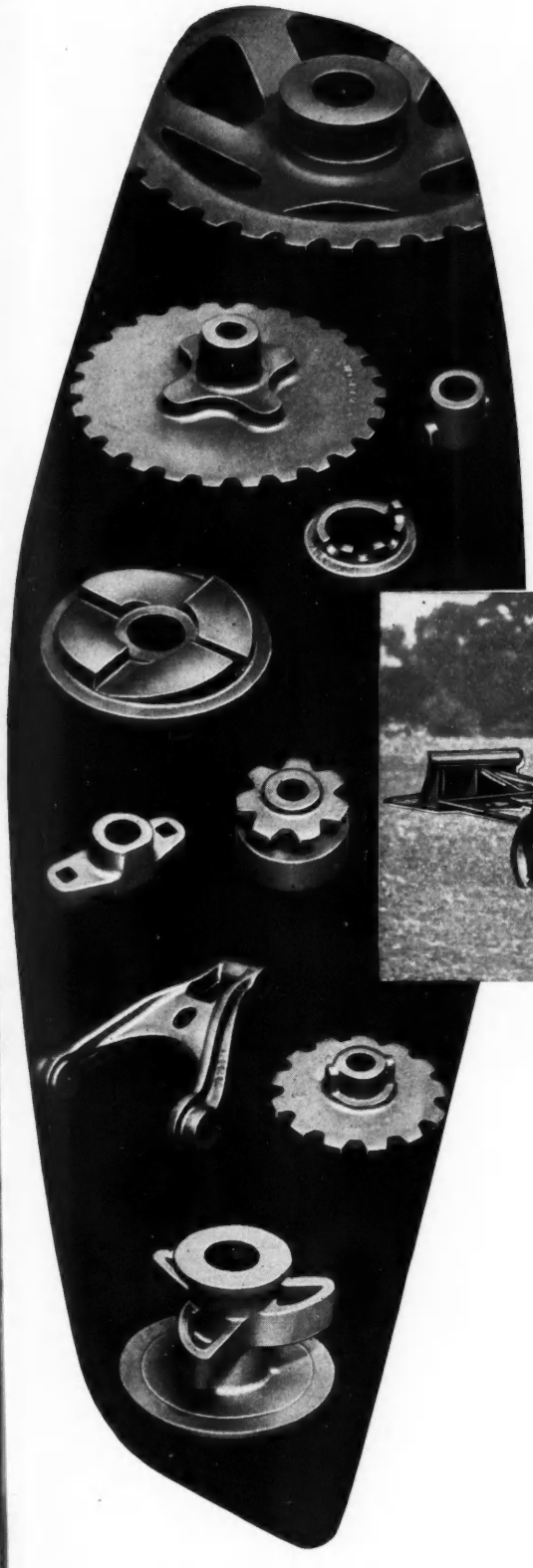

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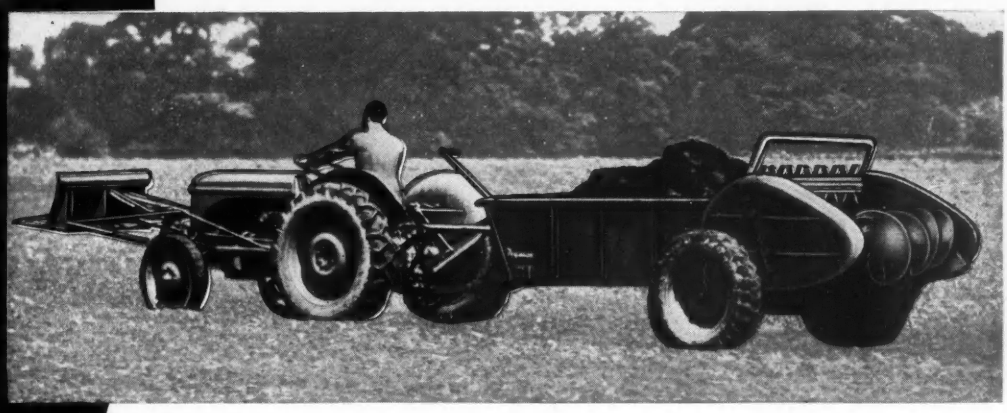

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JUNE 25, 1954

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